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EDITORIAL

OIDIUM HEVEAE

Reports on previous outbreaks of Leaf Mildew of the rubber tree caused by the fungus *Oidium Heveae* have been published in this Journal (Vol. 2, Nos. 1 & 2, 1930). In addition, the following articles have been published:—"Cost of Sulphur Dusting for Oidium Leaf Disease" (Vol. 2, No. 2, 1930), "Notes on Recent Observations on *Oidium Heveae*" (Vol. 2, No. 3, 1930), "Effects of Meteorological Factors on the Virulence of *Oidium Heveae* in Malaya" (Vol. 4, No. 2, 1932) and "Report on Sulphur Dusting Experiment" (Vol. 4, No. 2, 1932).

In this Journal Mr. Beeley contributes an article on an outbreak of the disease which occurred in certain districts during the early part of the present year. During this outbreak, large scale sulphur dusting operations with three types of dusting machines and two types of sulphur dust were carried out on two estates under the supervision of officers of the Institute. This outbreak was limited to districts in which the climatic conditions during refoliation after wintering appear to be favourable to the incidence of attack.

The experience gained in the dusting operations will be of considerable value in relation to treatment of future outbreaks. It is not possible however at the present stage to state with any certainty whether the treatment of the disease is economically sound at the present price of rubber. It is however considered that virulent outbreaks of the disease will be confined to districts in which the climatic conditions are in some years favourable.

Reports received during the present year indicate that the virulence of the disease was not so severe as in 1931 when the most severe outbreak occurred in Malaya.

The Acidity of Raw Humus in Relation to Natural Covers

The results of certain experiments on the acidity of raw humus in relation to certain natural covers and cultivated leguminous covers are described by Dr. Haines & Mr. K. S. Pillay, together with observations on the rate of decay of such material.

It was found that decayed timber and mixed jungle plants were the most acid samples examined, so that none of the other materials can be condemned on the grounds of acidity.

The results indicate that any differences in value between these covers in respect of humus formation cannot be attributed to their acidity.

Lightning Damage in Rubber Plantations

An article on the effects of lightning on rubber trees by Mr. Sharples describes in detail observations which have been made on the damage caused and especially the association of claret coloured bark canker at the collar of trees which have been slightly affected.

This damage, on restricted areas, has been of some importance and, in a number of cases in which the effects had remained unnoticed for some time, the damage has been attributed later to a peculiar outbreak of root disease and the original cause has been obscured.

These observations show definitely that lightning has been the primary cause of disease in a number of instances in which the damage has been attributed directly to a disease such as Die-back or claret coloured bark canker.

Lightning damage on young clearings has been very prevalent during the present year.

Manganese in Malayan Soils

It is known that certain manganese compounds have a deteriorating effect on raw rubber, causing softening due to oxidation, as in the case of copper salts. It was considered of interest to ascertain whether such compounds might be present in raw rubber owing to their possible absorption in latex from the soil.

A note on manganese in Malayan soils by Mr. Akhurst indicates that the content is generally low and that it is unlikely that any deterioration of raw rubber can be attributed to the presence of manganese compounds in latex derived from the soil.

Diseases of the Rubber Tree in Kedah

As a result of the virtual abolition of the Field Division, arrangements are being made for periodic tours by research officers

to States or districts which are situated at some distance from headquarters, so that a number of estates requiring advice can be visited during one tour, thus saving the time and expense involved in separate visits to individual estates.

Such visits also enable a useful summary to be made of conditions in relation to particular problems and a comparison with those existing in other parts of the peninsula.

In this journal a report by Mr. Napper on the problem of diseases of the rubber tree in the State of Kedah is published as a result of a tour made in the State. This report discusses in particular the disease problem in relation to the climate of Kedah which is different in some respects from most of the main rubber growing areas on the western side of the peninsula which lie to the south of this State. The incidence of root diseases, particularly *Fomes lignosus* and *Ganoderma pseudoferreum*, in relation to areas which were previously under crops such as tapioca is also of interest in certain parts of the State, where such crops were grown before the rubber tree was planted.

The possible confusion of damage caused by Pink Disease (*Corticium salmonicolor*) and Patch Canker and also that of damage to the tapping panel of the tree by Black Stripe or Mouldy Rot are also discussed.

Rubber & Latex Patents

In Europe and the United States of America suitable abstracts of patents are published in numerous technical journals, so that technical officers and others interested in any particular industry are acquainted early with any new advances or any restrictions imposed on their work as a result of the granting of patents.

In Malaya, publicity is only provided through the medium of the Government Gazette in which only the titles of approved specifications are given.

It is considered desirable in the interests of the rubber industry to publish periodically a list of patents relating to rubber which have been granted in Malaya.

In this journal, Dr. Wiltshire contributes an article in which the patent situation is discussed, together with a list of the patents relating to rubber granted from 1914 to 1932 inclusive. In the next number of the journal, abstracts of the more important specifications covering the same period will be published.

Subsequently it is proposed to keep the list up to date, by publishing in the journal brief abstracts of all Malayan rubber patents from 1933. It is hoped that these will be of interest and

value to those connected with the plantation rubber industry in Malaya.

As in the case of patents in other countries, relating to many industries, only a comparatively few of such patents are subsequently operated, the others remain only in the archives of the patent offices.

In a number of instances, patents are also taken out by large firms, not with the object of restricting the use of a particular process, but in order to avoid subsequent litigation, in the event of some other applicant obtaining a grant which may involve such restriction.

Use of Insecticides absorbed in Raw Rubber

An article in this journal by Mr. H. Pendlebury of the Selangor Museum describing the use of certain lethal agents absorbed in raw rubber for killing insects for entomological collections has a further significance which is indicated in a footnote to the article.

It is considered that volatile insecticides which can be absorbed by raw rubber may be of greater utility when applied in this manner, since they will be volatilised more slowly and therefore have a more lasting effect. It is proposed to test the value of such insecticides applied in this manner for the treatment of white ants and other pests which occur in the soil.

Cultivation and Fertiliser Experiments:—

A further progress report of measurements of growth of young rubber plants on various Blocks at the Experiment Station, on which experiments on fertilisers, cover crops, natural growths and cultivation have been carried out is published by Dr. Haines.

As will be seen in the summary of this article, there is at present no significant difference between growth on the various manured and control plots in the fertiliser experiment. Creeping covers, especially where these show a luxuriant growth, definitely retard the growth of the rubber trees. The natural uncontrolled growth of secondary jungle in Block 11 has also caused considerable reduction in growth of the rubber but it will be of interest to watch the progress of the plot which has recently been completely cleared. A very definite effect of the competition of tapioca as a catchcrop is also shown in the experiments on Block 23.

OIDIUM HEVEÆ

Report on the 1933 outbreak of Hevea leaf mildew

BY

F. Beeley

On February 8th a letter was circulated to the press for publication setting forth the symptoms of the disease and requesting that samples of leaves suspected of attack should be sent to the Institute for examination. As a result of the appearance of this letter in the Malayan Press an appreciable number of samples of diseased leaves have been received. It is interesting to note that no reports of the outbreak of Oidium were received prior to March 7th, although wintering was then well advanced and in many districts some 15—20 per cent. of trees had obtained their new leaves.

In the week, March 8—14th, six cases were reported from Negri Sembilan. From the 15th to 21st a further twenty six cases were reported from both Malacca and Negri Sembilan while from the 22nd to 28th a further twenty four cases were reported chiefly from these districts with a few in Johore, and isolated occurrences in Sitiawan and Province Wellesley.

Nine cases only were reported during the period March 29th to April 5th, since when no further cases have come to our notice indicating that the outbreak rapidly abated as from that date.

The total number of reports received therefore, despite the press notices, was only 65 as compared with 38 in 1932, and 61 in 1931, the latter being considered the most severe outbreak ever known in recent years. Whereas the reports in 1931 came from practically all parts of the western States, those of 1933 came chiefly from the coastal districts of Negri Sembilan and Malacca and certain parts of Johore, while the reports and observations in other parts of the country indicate that little or no damage was caused by Oidium this year as compared with 1931. This is thought to be due to the continuous wet weather experienced in those districts during the refoliation period.

From the information supplied by the managers of estates the following points stand out.

1. That during the very dry weather preceding March 7th a normal though severe wintering and refoliation was taking place, and that trees refoliating previous to that date were not attacked by the fungus.

2. That light rains falling in the early period of March in the Malacca and Negri Sembilan districts caused a rapid and almost epidemic spread of the disease.

3. That in most cases the lower shaded branches were most heavily attacked.

4. That the exceptionally heavy rains falling during March in central and northern Selangor, Perak, South Kedah and Pahang had prevented a similar attack in those districts, although a hot dry period of weather causing a similar severe wintering had been experienced in those districts.

5. That in the districts most affected viz. South Selangor, Negri Sembilan, Malacca and parts of Johore the outbreak this year was not so severe as it was two years ago, nor so extensive, while even in the worst districts many blocks of rubber are to be found bearing an excellent foliage, such areas usually lying on flat peaty lands or on sloping ground bearing a deep clay loam soil. Even on estates bearing a general heavy infection the disease has been serious only in patches, here and there; a few acres have suffered a heavy leaf fall, while in between are areas bearing quite good foliage. This fact will have a distinct influence on control of the disease when, for reasons of economy, selective dusting of the worst areas only need to be carried out.

6. That trees of all ages may be attacked, from the undergrowth of seedling rubber to trees of thirty years and over.

Older trees, however, suffer more severely than the younger. The observation that seedlings of a few months old may be attacked is new to Malaya. Previously it had been thought that rubber trees were not susceptible to Oidium attack before the age of three years had been attained. Leaf fall of such young trees had not been observed by the writer.

7. That the inflorescence is still the main seat of attack. Often a tree may appear to have perfectly healthy foliage while the flowers are badly diseased. This appears to be due to the natural hirsute condition of the flowers and flower stalks providing a suitably cool, damp, and protective environment for the fungus. Hence, even in Selangor, certain areas kept under observation have failed to produce a crop of seed although the foliage shows little or no signs of attack by the Oidium fungus. A recent count of seeding trees in an area of rubber in Selangor showed that only 4 per cent. of the trees bore fruit, and those bore only a very small quantity.

An analysis of the replies given to our published request for information regarding the disease shows that,

(a) the number of reports of the disease increases with the age of the trees, i.e. areas of old rubber suffered more than areas of young rubber.

(b) the number of reports of the disease decreases with increased intensity of the disease, i.e. many estates reported a light attack while very few reported heavy attacks.

(c) many more reports were obtained from estates having poor sandy soils than from estates having heavy clay soils. Fewer reports came from estates having peat soils, while loam soils fell between peat and heavy clay soils.

(d) few reports were received from very dry districts e.g. Province Wellesley and Kedah with 0.33 to 2.90 inches of rain in February and from very wet districts e.g. inland Perak, and Selangor with 8—13 inches, while the great majority of reports of the occurrence of the disease came from estates having between 3 and 6 inches of rain in February and between 3 and 6 inches in the first half of March.

The above analysis in graphical form together with a plan map of the distribution of the reported occurrences of the disease are attached and show that the disease has occurred chiefly in Malacca and Negri Sembilan with isolated cases in Johore, Sitiawan and Province Wellesley. Though only nine estates in Malacca Territory reported the occurrence of Oidium, actual observation indicated that practically the whole of that state was infected, and suffered a comparatively heavy fall of leaf.

This year's attack of *Oidium Heveae* ended about the first week in April since when no cases of further outbreaks have been received. The recovery towards the end of the month was remarkably good, owing most probably to the advent of regular fairly heavy rains. The new foliage is very good and is considered to be much better than in the previous few years. Seed is very scarce and has formed only on those trees which wintered and flowered before the attack.

The districts which have suffered most severely this year are roughly as follows:—

(a) Malacca Territory except the inland district around Batang Malaka, though Chabau nearby had quite an appreciable attack.

(b) Negri Sembilan, the districts of Linggi, Rantau, Rasah,—Port Dickson, Labu and Setul.

(c) Selangor—the estates along the valley of the S. Sepang in the district of Kuala Langat.

(d) Johore—mild attacks have been experienced in the districts of Segamat and Kluang.

In regard to the Dindings little can be said owing to lack of opportunity for visiting that district. Only two estates reported the disease this year whereas in previous years a number of estates in the Sitiawan district were known to have experienced mildew leaf fall.

It is well to note here that well over 25 per cent. of the leaf specimens sent in were diagnosed as being attacked not by Oidium but by insects, producing a malformed leaf at first somewhat similar to that caused by the mildew fungus. It was found that in such cases the damage was caused firstly by an Attid spider which weaves its web around the very young leaves. Leaves so bound together in triplets form between them an ideal damp chamber for the development of leaf spotting fungi of the *Helminthosporium* and *Gloeosporium* types. These fungi cause death of the leaf tips which later are torn apart by the wind thus resulting in the ragged appearance of the leaf. Leaves damaged in this way are usually malformed, the tips discoloured and badly torn, while even healthy parts of the leaves have been eaten away and are often badly spotted.

Other leaf eating insects also fond of the shelter provided by the bound leaves are responsible for further damage. A weevil *Phytoscaphus leporinus* Faust. of the family *Anculionidae* is the most common of the leaf eating insects found in such cases while the common mite, *Tarsonemus translucens* is also frequently observed within the sheltered leaf chamber.

This spider pest has been active particularly in young immature rubber, 1—6 years old, in the States of Selangor, Perak, South Kedah and South Johore and seems to prefer a rainy season, but is much less dependent on climatic conditions than is Oidium. The point is mentioned here to avoid confusion with the Oidium disease.

The Problem of Control

The question of control of the disease now arises. Liquid sprays, owing to the heavy costs of labour, haulage and power plant must be ruled out. Dusting of fungicidal powders has proved the most economical and feasible method of control.

The problem of the necessity for carrying out extensive treatment for control of Oidium is rather a thorny one. The following brief points are however put forward.

It should be noted that really heavy rains or complete lack of rain prevent an epidemic spread of the disease. The fungus appears to be so dependent upon young leaf tissue for its development that little benefit can be expected from dusting before the new young leaves begin to appear. Having efficiently dusted the

buds and young leaves, the sulphur may be expected to give a prophylactic effect for a period of about 7 to 10 days, provided that no heavy rain falls during that period. It is of little advantage to dust during wet weather for, not only is it difficult to get the sulphur powder on to the trees but, having done so, it will be washed off by the rain within a few hours, thus leaving the leaves unprotected until the next round of treatment.

Dusting should start only when the early attack of young leaves takes place. A severe wintering will most likely indicate a rapid and more uniform refoliation, in which case only a brief yet intense attack need be expected, and two or three rounds of dusting will probably give adequate control. A slow, desultory wintering indicates an indistinct season, showers instead of definite drought, and then is the time to expect a heavy attack of leaf disease for the following reasons (a) comparatively cool moist conditions obtain for growth of the fungus (b) slow wintering and slow refoliation giving time for spread and time for action upon the leaf (c) suitable young leaves are available over a long period to maintain a longer active life of the fungus.

In most plantations it is noticeable that the old rubber suffers most and, even in such areas, only patches of a few acres in extent may be affected sufficiently heavily to merit dusting, so that only selective dusting of the worst areas need be attempted, such areas being singled out for dusting by observation during the period of refoliation of the trees.

The adoption of correct methods of cultivation within rubber plantations so as to ensure the maintenance of vigour of the trees must necessarily be a first item of disease treatment.

Points brought to light by recent experiments on dusting indicate:—

(a) that more efficient control is obtained by dusting 5 lbs. of sulphur at intervals of 7 days only than by dusting 7 to 10 lbs. at intervals of 10 days. The 10 day interval proved too long for this year's sudden, brief and intense attack.

(b) early and late season dusting is of little if any advantage so that it is required to dust only during the refoliation period when the main mass of leaves are in the young stage.

(c) an economic area for treatment for one gang of labourers and one machine is about 2,000 acres per season, when treatment 5 times at the rate of 5 lbs. per acre at 1933 prices can be accomplished at a cost of a little over $2.00 per acre including share of costs of machine and European supervision.

Apart from these facts it is reasonable to ask what benefits one might hope to derive from this expensive treatment. In regard to yield of rubber per acre, it is not yet possible to state

that a definite increase in yield can be expected following dusting. It can only be stated that yields do improve slightly as a result directly of dusting. A second direct benefit is the assurance of improved foliage and absence of leaf fall thus avoiding unnecessary drain on the living resources of the tree. From results of experimental dusting in Malaya it can be said that improved foliage, improved bark and slightly improved yields may be expected, while benefits from additional shade to soil, improved soil flora, protection of bark from direct sun, all tend to improve conditions of growth for the trees. The estimation of the value of these factors is however very difficult and requires further prolonged investigation.

However necessary dusting may be from a pathological point of view it is not yet decided whether or not the operation is economically sound at present commodity prices. In many parts of Malaya conditions are suitable to rapid growth of trees throughout the year so that they are able themselves to overcome, and almost completely recover from the disease. In certain parts however e.g. the districts of Negri Sembilan and Malacca mentioned above, where conditions of soil and climate are so favourable, it is well worth while considering dusting on a limited scale. Large estates could derive benefits from one machine, and smaller estates might combine and utilise one machine jointly, in each case selectively dusting the worst affected areas. If the required benefits are derived from this limited treatment it can in future years be extended as required or as further funds become available.

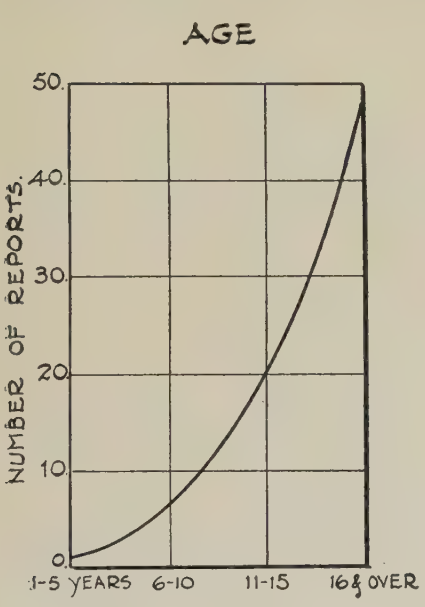
While strongly recommending such experimental dusting in Malacca and Negri Sembilan, and possibly the districts of Segamat and Sitiawan, this year's records indicate that the disease is waning and treatment will be unnecessary on estates in Selangor, Perak, Kedah, Province Wellesley, Pahang and Kelantan.

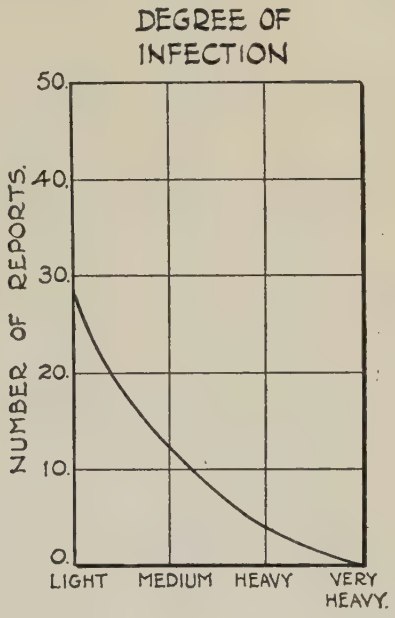
All seed gardens and budwood multiplication nurseries should be dusted with sulphur as a routine practice, so as to maintain continual protection of such valuable material not only from Oidium but from many other fungi and pests capable of causing damage to the rubber leaf, buds or flowers.

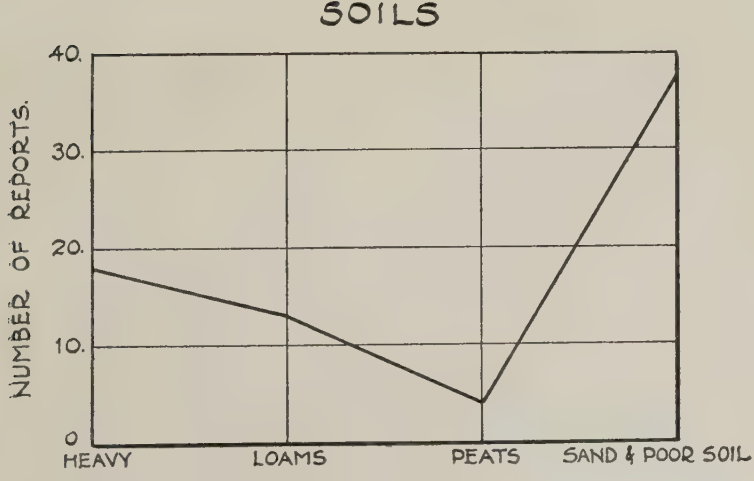
In conclusion I would like to thank all those managers of estates who sent in samples of leaves, accompanied by the various items of information for which we asked and which have proved of great value. It is a pleasure to record the tremendous amount of interest taken in this subject by the planting community and the great help that we have received from them during the investigations.

OIDIUM HEVEAE

GRAPHICAL ANALYSIS OF REPORTS RECEIVED 1933.



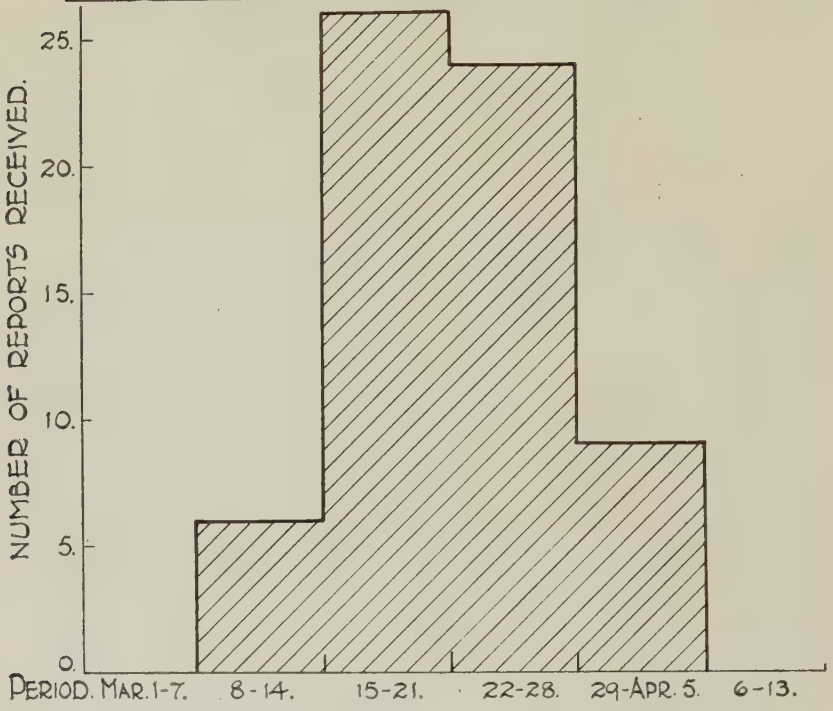




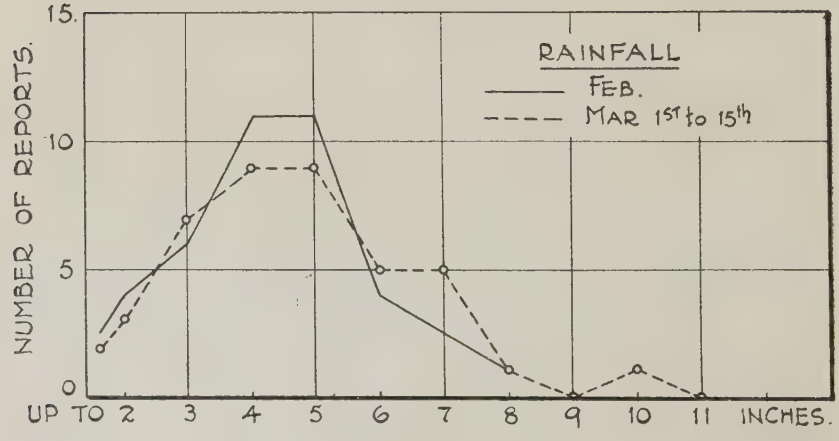
OIDIUM HEVEAE.

1933

NUMBER OF REPORTS RECEIVED PER WEEK PERIOD.



NUMBER OF REPORTS OF OIDIUM HEVEAE COMPARED WITH REPORTED RAINFALL.



DISTRIBUTION of OIDIUM HEVEAE
IN
MALAYA
1933
CONFIRMED BY R.R.I.
AREAS WHERE LEAF FALL OCCURED.
ALOR STAR
KEDAH
SIAM
PENANG
PERAK
KELANTAN
TAIPING
IPOH
TRENGGANU
CHINA SEA
STRAITS OF
KLIPIS
PAHANG
SELANGOR
KUALA LUMPUR
NEGRI SEMBILAN
SEREMBAN
PT. DICKSON
GEMAS
MALACCA
MALACCA TOWN
JOHORE
MALACCA
SUMATRA
SINGAPORE

NOTE ON THE ACIDITY OF RAW HUMUS IN RELATION TO NATURAL COVERS

BY

W. B. Haines and K. S. Pillay

In previous contributions the Soils Division of the Rubber Research Institute has endeavoured to make it clear that the main feature of importance in the management of soils under rubber cultivation is the upkeep of the humus supply and the associated nitrifying activities of the soil. Interest at the present time centres upon the contribution to these ends which can be made by the association of a natural undergrowth with the rubber. Such an undergrowth may increase the amount of decaying vegetation, check erosion, and assist the activity of micro-organisms by protecting the surface soil from extremes of dryness and of heat. During the period of its establishment this undergrowth must, of course, increase the demands on the soil but, once a stable cycle of growth and decay is established, the presence of the undergrowth must be expected greatly to promote soil activity. Thus the adoption of clean-weeding was based upon the single isolated consideration of competition, without duly weighing the sequence of events.

The experience which has so far been gained with natural undergrowth has been very varied, but the results need not appear puzzling if explanation is sought in the underlying principles. The following are the main points for consideration:—

(1) The intensity of competition between crop and undergrowth. This will depend upon the present fertility status of the soil. If this is satisfactory, competition may hardly be noticed but, if conditions are so poor that the rubber is not strong enough to maintain its natural predominance by shade, then further deleterious effects on the rubber may result temporarily from a vigorously competing undergrowth, even though the process ultimates in soil improvement.

(2) The plant species which appear must depend primarily upon the seed-bodies in the soil. The case is one of re-colonisation of areas reduced to sterility by clean-weeding, so that wind-borne seeds or spores (lallang, stagmoss, bracken and ferns) have

by far the best chance to predominate at first, while other plants whose seeds are carried by squirrels or birds only come in slowly from adjacent jungle or belukar, unless deliberately collected. Seed-production in relation to development must also be studied. Thus the Straits rhododendron seeds very much earlier than most shrubs and, although not undesirable in itself in its younger stages, it may quickly establish predominance if left to propagate.

(3) Treatment of the undergrowth must be designed to suit the conditions aimed at. Thus indiscriminate slashing may destroy the very plants whose shade is so desirable (for controlling grass &c.), by injuring them in early seedling stages before they are noticed.

(4) The property chiefly desirable in the falling debris is rapidity of decay, and this depends upon moisture and the nitrogen content more than upon any other factors. This point has already been discussed in Mr. Akhurst's paper on "Carbon and Nitrogen Contents of Some Natural Covers" (This Journal Vol. 4, No. 2).

In connection with the last point it has often been maintained that certain plants give rise to undesirable acidity of the soil. It is known that stagmoss, for instance, favours the more acid situations and that a little lime greatly aids its suppression. The results recorded in the present note were the outcome of a preliminary examination of this question. Plant residues in the earlier stages of decay (raw humus) were taken from various sources and careful measurements made of their acidity. The results are by no means complete enough for a detailed criticism, but are presented at this stage because they do at least afford some background against which to compare the various views put forward. This is the more important since it is not always realised how differently questions of acidity bear upon forest conditions in the humid tropics when compared with the temperate zone soil management with which we are more familiar.

For the benefit of the non-technical reader a short explanation of the nature of acidity must be given. In the older measurement of acidity in soil work the amount of lime was found which was required to react with the soil to bring it to neutrality; this was known as the lime-requirement of the soil. Further development showed that this quantitative factor is inadequate for many purposes so that the conception of a qualitative or intensity factor in the acidity must also be introduced. The physiological effect, for instance, of soil acidity upon a root-hair or a soil micro-organism depends not so much upon the amount of acid (measured by the lime requirement) as upon the kind of acid, or the intensity of its chemical action. This intensity can be expressed as the concentration of hydrogen ions in the solution under test. The

scale used in this measurement is known as the *p*H scale, and it is sufficient for the reader to know that on this scale *p*H 7 expresses the neutral point (the hydrogen ion concentration of pure water) while successively lower figures express increasing acidity and higher figures increasing alkalinity. The *p*H of a solution affects the colours shown by various dyes, which fact forms the basis of the colorimetric method of determining *p*H. This method is simple, but not very accurate and is subject to various pit-falls in inexpert hands. The method for all accurate estimations depends upon measurement of electric potential with the use of specially designed electrodes.

A combination of the two conceptions outlined in the last paragraph leads to the method of expression of the results here presented. The samples are subjected to a series of measurements which enable the lime requirement to be ascertained, not only for the netural point, but for any *p*H between this and the original *p*H of the sample. Thus the behaviour towards processes which will tend to produce changes in acidity can be determined, which is of great importance. A material which is resistant to such changes, that is, which reacts with a relatively large amount of lime for a small change in *p*H, is said to be well buffered. Thus a high buffer capacity will (for the same change in *p*H) mean a high lime requirement, and a stable behaviour or resistance to change. In the case of a soil this would make a corrective dressing of lime more expensive, but it is to be noted that, if the *p*H is already at a satisfactory value, the high buffer capacity (or stability of reaction) will be a desirable feature.

The question of deciding what may be regarded as a satisfactory value of *p*H is one for which we have but a sparse background of knowledge. The *p*H of Malayan soils carrying good rubber is usually between 4.3 and 5.0. Is it an advantage to correct this acidity more towards the neutral point? Results of experiments under the conditions of temperate zone forests indicate that nitrogen fixation will go on in forest litter above *p*H 6, but is inhibited by acidity values below 5. Great care must be exercised in applying such results to tropical forest conditions and, until we have a much better knowledge of the micro-biology of our own soils, it is safer to assume that any effort to change the *p*H from values usually found must be very firmly based upon experimental results before being undertaken.

Experimental

Thirteen samples altogether have been examined, of which eight were produced under controlled conditions and five were

taken from the field. The plants chosen for the artificial preparations were:

(1) bracken (*Gleichenia linearis*),
(2) rubber (leaves and twigs),
(3) stagmoss (*Lycopodium cernuum*),
(4) *Cassia hirsuta* (an indigenous shrubby legume with good characters).

Thus according to general opinion, two members (2 and 4) were likely to produce suitable humus material, while two (1 and 3) were more or less suspect. The fresh plant material was collected and allowed to decompose in the shade under optimum conditions of moisture and aeration. One series received plain water and the other lime water for the maintenance of the moisture content. These prepared samples were supplemented by five others taken from the field and representing material from,

(5) decayed wood,
(6) mixed leaf-fall of virgin jungle,
(7) bracken,
(8) *Crotalaria anagyroides*
(9) fern (*Blechnum orientale*).

The results of the *p*H titrations are shown in the figure and table. The laboratory method followed was that used by Hardy and Lewis in similar measurements on soil, viz. 100 gms. of the substance are mixed with 400 c.c. of M/5 calcium chloride solution (*p*H 7.06) and titrated electrometrically with 0.042 N calcium hydroxide solution to the neutral point, using the quinhydrone electrode. The buffer capacities recorded in the table are simply calculated by drawing tangents to the smoothed experimental curve. The experimental points are omitted from some of the curves in the figure to save the confusion of crowding.

The samples receiving lime during their formation were neutral in each case. The addition of lime was not observed to cause much difference in the rate of decay, which was rather contrary to expectation. However, all the modern results on the formation of composts and artificial farmyard manure suggest that an addition of nitrogen would be of first importance in hastening decay. This is borne out by the rates of decay observed in the samples. Sample No. 4 from the nitrogenous plant was decomposed in about one month, rubber debris came next with double that time, while the stagmoss and bracken were not fully decomposed at the end of nine months. These rates would correspond to the relative amounts of nitrogen present in the original tissues. It is possible that the presence of lime may have helped nitrogen fixation (by giving a neutral *p*H as required by most nitrogen fixing organisms), for the nitrogen remains for the time

being in the organisms themselves and so does not in the earlier stages contribute to the question of mass-decomposition.

Discussion

A critical examination of the results indicates that only the fringe of the subject is touched, but it is considered worth-while to present them at this stage because they bear upon points which are at present much debated.

Samples 5 and 6 (decayed timber and leaves of mixed forest plants) conform to the natural jungle conditions, and it will be seen that these are the two most acid samples. It appears therefore that none of the material examined can be condemned as giving rise to humus of too acid a nature. Rubber has seldom grown in undisturbed jungle soil (burning and clearing very much disturb the surface layer), but experiments have proved that phenomenal growth is possible, showing that it is quite safe to assume that the highly acid raw humus is not of itself unfavourable to conditions required for the rubber crop.

All the samples prepared artificially have a lower acidity than the field samples. The latter have been formed under intense leaching conditions, and they will also contain material of a greater age (of decay) than the laboratory samples. Thus the natural samples will suffer a greater removal of the ash constituents or bases and perhaps a greater accumulation of acid end-products, which would explain these differences.

Of the samples prepared artificially, stagmoss is the most acid, but is far from being as acid as the field group of samples. Curiously enough a field sample of stagmoss debris, which was also examined, proved to be the least acid of the field samples. This should dispose of the idea that stagmoss has something inherently acid in its nature and is objectionable on that account.

These conclusions are reached from the examination of the simple available data. It is clear that the natural *p*H range with which we are dealing is lower than that covered by most of the scientific work conducted in other parts of the world. It is therefore difficult to construe clearly the processes of decomposition in terms of the micro-biological activity. Suffice it to say that discrimination as to natural covers and their treatment depends for the present upon an understanding of broad general features which need not be hidden from a patient observer. Competition provides the chief key to understanding, while next in importance is the rate at which the cover returns for circulation in the soil those plant foods which it has removed in its growth. Probably the greatest scientific objections to stagmoss and bracken lie in their slow rate of decomposition and a competing habit which excludes

TABLE

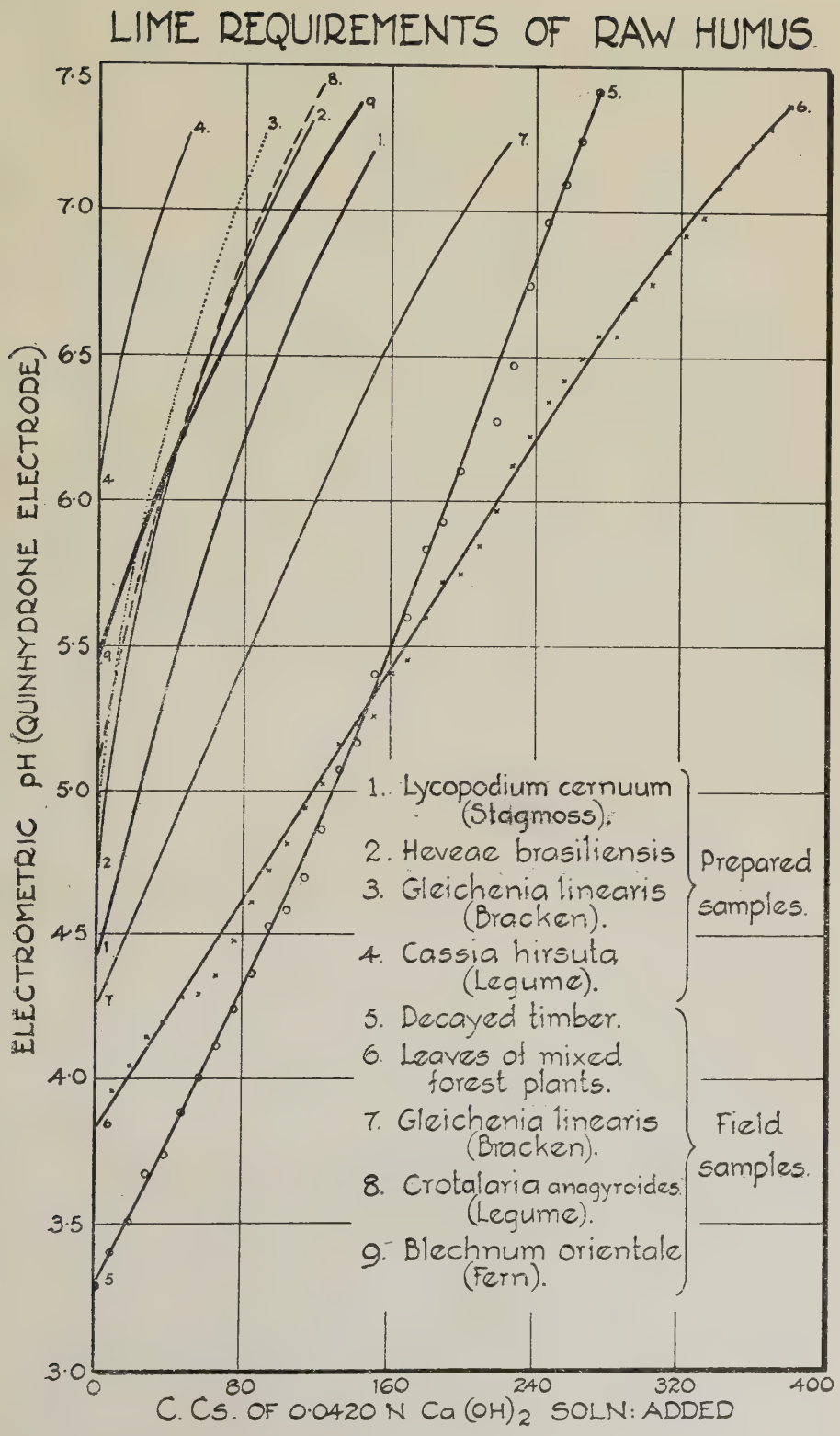
Acidity, lime requirements, and buffer capacities of raw humus.

Serial No.		Description of the humus	Original *p*H of 100 grs. of substance + 400 c.cs of neutral M/5 $CaCl_2$ Solution	Lime requirements expressed in percentages of Calcium carbonate		Buffer capacities at *p*H			
				for *p*H 5.5	for neutrality	4.0	5.0	6.0	7.0
Samples from controlled experiments conducted at the laboratory	1	*Lycopodium cernuum*	4·43	.095	0.290	—	0.0178	0.0219	0.0336
	2	*Hevea brasiliensis*	4.73	.037	0.204	—	0.0075	0.0153	0.0304
	3	*Gleichenia linearis*	4.89	.023	0.166	—	0.0084	0.0141	0.0248
	4	*Cassia hirsuta*	6.05	—	0.080	—	—	—	0.0241
	1a-4a	Limed series (all similar)	7	—	—	—	—	—	—
Field samples more thoroughly decomposed under natural conditions	5	Decayed timber	3.29	.336	0.520	0.0316	0.0302	0.0247	0.0214
	6	Leaves of mixed forest plants	3.84	.352	0.716	0.0375	0.0431	0.0426	0.0513
	7	*Gleichenia linearis*	4.27	.179	0.434	—	0.0282	0.0296	0.0420
	8	*Crotalaria anagyroides*	5.11	.032	0.200	—	—	0.0182	0.0315
	9	*Blechnum orientale*	5.46	.004	0.238	—	—	0.0250	0.0380

other plants. Returns to the soil can be hastened by pulling and slashing, and by crushing debris into contact with the soil to keep it moist. Although the nitrogen content of the debris plays a leading part in the rate of decay, this can only come into force if first of all the necessary moisture content is maintained.

Summary

Titration curves are presented to compare the acidity of various samples of raw humus, and the results indicate that, if marked differences in value exist between common natural covers as humus formers, such differences cannot be ascribed primarily to the acidity factor.


LIME REQUIREMENTS OF RAW HUMUS
ELECTROMETRIC pH (QUINHYDRONE ELECTRODE)
7·5
7·0
6·5
6·0
5·5
5·0
4·5
4·0
3·5
3·0
0
80
160
240
320
400
C. Cs. OF 0·0420 N Ca (OH)2 SOLN: ADDED
1. Lycopodium cernuum (Stagmoss).
2. Heveae brasiliensis
3. Gleichenia linearis (Bracken).
4. Cassia hirsuta (Legume).
Prepared samples.
5. Decayed timber.
6. Leaves of mixed forest plants.
7. Gleichenia linearis (Bracken).
8. Crotalaria anagyroides (Legume).
9. Blechnum orientale (Fern).
Field samples.

*LIGHTNING DAMAGE IN RUBBER PLANTATIONS

BY

A. SHARPLES

In the paper mentioned in the footnote I state the conclusion that lightning is of primary importance in the causation of diseases found on coconut plantations in Malaya. This conclusion naturally brings to a focus the question as to whether similar phenomena are not met with in rubber plantations. When considering this question the difference in structure of the two types of trees must be kept in view. The coconut palm is a monocotyledon and has no stem cambium, the growth initials or bud-tissue being concentrated in the "cabbage" and, if the tissue composing the so-called cabbage is killed, growth in length cannot continue. On the other hand, the rubber tree is a dicotyledon with stem cambium, by means of which it increases in girth year by year. Parts of the stem cambium may be killed or injured but, if healthy cambium remains, growth in general may be continued by the sprouting of a dormant bud which develops as a side-shoot. Therefore, although lightning might cause injury in both coconut and rubber plantations the observed symptoms will probably be very dissimilar. The symptoms on coconut plantations are very striking because the death of the tree follows the injury of the meristematic tissue concentrated in the "bud". But in rubber trees the upper portion of the stem may be killed by lightning while the lower portion is unaffected; in such cases growth can be continued by the shooting of lateral buds from the healthy tissues. There are many references in the standard books (1 & 2) to lightning injury on rubber, but they are generally very indefinite and only record the wound effects supposed to be caused by lightning. The following quotation (5) summarises the position.

"The pernicious tendency of lightning to cause damage to plants has been well shown in rubber. Many cases have been investigated and talks with planters demonstrate the common occurrence of lightning injury to young rubber. The "die-back"

*Largely a copy from a paper entitled "Lightning Storms and their significance in relation to diseases of (1) *Cocos Nucifera* and (2) *Hevea brasiliensis*:" Anns of applied Biology Vol. XX, No. 1, pp. 1—22, February, 1933.

of 4-12 months' old trees wherein the tops wilt, the green bark turns black with the appearance later of three to four different caulicolous fungi, finally resulting in death, is apparently attributable to lightning. The affected trees occur in patches and, when cut back to stump height, regenerate rapidly with a discontinuance of the damage. The influence of lightning on the growth of trees, if the trees are not killed outright, usually takes the form of a modification of the developing wood cells of the season so that the continuity of the normal structure of the wood is broken and a "lightning ring" is formed".

Recent observations prove that lightning effects in rubber plantations are quite as definite as those in coconut plantations and strongly support the observations made and conclusions arrived at by the investigation on the causation of diseases of coconut palms.

The observations on the effects of lightning on rubber plantations can be most conveniently treated under two headings:

(a) Lightning effects and "die-back"; usually found in young trees.

(b) Lightning effects and "claret-coloured bark canker at the collar"; found on trees from 4 to 20 years of age.

Lightning effects as in (a) above:—The symptoms shown by young rubber trees affected by lightning are well described in the quotation already given. The important point is that few losses occur, for young trees are seldom killed outright and, when cut back to stump height, the cut being made through healthy tissue, regeneration is rapid, the growth being continued by the shooting of lateral buds from the unaffected tissues. Careful examination of the root systems of young trees affected by lightning show that they remain healthy; a root examination is necessary to make certain that the symptoms are not the result of an attack by one of the usual root disease-causing fungi.

The following is a record of an area affected by lightning. The area was planted in 1928 and budded in December —January, 1929-30. There were two areas affected, a large area situated on an exposed hilltop, and a small area on the side of a hill, one mile distant.

The lightning storm, which occurred on November 3rd, 1931, was a notably severe one. Nothing unusual was seen until November 11th, 1931 when over 100 trees were found showing the symptons described above. The writer was notified on November 11th, 1931 and inspected the area on November 13th, 1931; on this visit a careful root examination was undertaken, and this showed the root systems to be perfectly healthy. In the large area 121 trees were treated; of this number eight had

to be cut out completely, the rest were treated successfully by pollarding. The number of treated trees in the smaller area was twenty, of which five were total losses. The diagnosis of lightning strike could be made with confidence.

Lightning effects as in (b) above:—This case of lightning injury, on rubber trees 4-5 years old, was investigated in March, 1931. The trees were planted on a hilly slope on contours; the ground was covered by a thick cover crop of *Centrosema pubescens.*

A lightning storm in close proximity was noted 5 days before the affected trees were found. Trees on two contours were affected; on the lower contour only two dead trees were found, but on the upper, one dead tree and in addition seventeen neigh bouring trees, all slightly affected at soil level, were observed.

The dead trees were taken out immediately. The seventeen trees, presumably slightly affected by lightning, showed discoloured cortical tissues at ground level. This discoloured tissue formed a patch about 6 ins. square and extended through the thickness of the cortex. The discoloured patches of cortical tissues showed symptoms exactly similar to those described for the cortical disease of Hevea, long known as patch canker or claret-coloured bark canker. A discoloured patch was stripped from the wood and isolations were made in the laboratory in various ways. Thirty hours after setting in the culture media a profuse growth of white mycelium was evident, which ultimately proved to be a species of Pythium.

The obvious point is that, if the trees with the bark attack at the collar had remained unnoticed at the time the dead trees were taken out, and had been left untreated, there would have been a peculiar outbreak of root disease reported a few months later, for which it would have been difficult to provide the correct explanation. This is a parallel case with the delayed effects observed in the coconut palm investigations. Later investigations, described below, provide further evidence showing that the discoloured tissue at the collar is typical of claret-coloured bark canker.

Before describing other recent interesting cases of the association of lightning effects on rubber trees and claret-coloured bark canker at the collar a few remarks on the disease may be of interest. This disease, known variously as claret-coloured bark canker, purple canker or patch canker, is a well-known disease of *Hevea brasiliensis* and was first discovered on this host in 1903. Petch records that it has been found in Java, Sumatra and Fiji, and that it is said to be of rare occurrence in the Federated Malay States. Recently (1933) it has been reported that patch canker is common and does considerable damage in rubber plantations

in Kedah, but this report has not been actually verified. The following remarks, with reference to this disease, are taken from the same authority (1).

"The most serious cases of claret-coloured bark canker are those in which the tree is attacked at the collar. The disease may then run rapidly round the base of the tree and kill it in a few weeks.

"Bark attacked by claret-coloured canker has a peculiar smell, which soon attracts boring beetles, particularly a small brown beetle about the size of the shot-hole borer. When the disease has been in progress for a few weeks, the decayed patches are usually riddled with this borer.

"The Phytophthora which causes claret-coloured bark canker is identical with that which causes the similarly coloured canker in cacao."

The cases of claret-coloured canker in Malaya recently found associated with trees affected by lightning are invariably those in which the trees are attacked at the collar. The chief danger in such cases is that boring beetles, which are attracted by the peculiar smell of the affected tissue, may enter the tree and, if this happens, such trees succumb in the majority of cases.

With reference to the fungus causing the symptoms, the position was not clearly understood until 1929, when Thompson (3) showed that two species of Phytophthora and one species of Pythium are direct causes of patch canker in Malaya; further, that seven other species of Phytophthora isolated from host plants other than Hevea are capable of causing patch canker symptoms if artificially inoculated into the bark of rubber tree. Thus it seems obvious that more than one species of Pythium or Phytophthora may be found to be involved in the production of the diseased, claret-coloured, cortical tissue which has been found at the collar of trees affected by lightning.

The most noteworthy occurrence of the association of lightning and claret-coloured bark canker at the collar can now be described. During the investigations on lightning effects the writer has noted the dates of lightning storms occurring in the vicinity of Kuala Lumpur. Two heavy thunderstorms were noted on November 18th and 19th, 1931; both took place between the hours of 1.30 and 4.30 p.m. On December 2nd, 1931 a report of lightning damage was received from an estate only 3 miles from the Rubber Research Institute. A visit was made and several lightning patches were found on trees 20 years of age. There was no cover crop present.

Fig 1. shows the patches situated on a direct north and south line. The distribution of the affected trees in each block is shown

in Fig. 2. The total number of affected trees was 56. Of these 8 were killed outright and 48 were treated for claret-coloured bark canker at the collar.

The symptoms shown by the affected trees could not be mistaken. The badly affected trees which had to be cut out were killed as a result of the scorched cortical tissues being rapidly invaded by the Diplodia sp. which is the cause of "die-back" in rubber trees. This black, discoloured cortical tissue proves attractive to boring beetles, and the rapid penetration of these insects into the stem results in the early death of the tree. The borer attack on badly affected trees is of importance when considering treatment of the slightly affected trees, which again showed typical symptoms of claret-coloured canker at the collar, because, as mentioned above, such affected cortical tissue attracts boring beetles, and on this account it is imperative to remove it as quickly as possible to prevent penetration by the insects.

The slightly affected trees all showed the typical symptoms of claret-coloured bark canker at ground level, in greater or less degree. Figs. 3 and 4, show the appearance of an area of discoloured cortical tissue, 10 in. by 5 in. which was stripped from the wood at the collar of one tree. Fig. 3 shows the extent of the discolouration of the affected area when the outer bark layers are scraped away. Fig. 4 shows the appearance of the inner surface of the affected cortical tissues; this surface is directly in contact with the wood, and a reflection of this appearance is found on the wood surface. The white patches are pads of coagulated latex which has infiltrated from the attacked cortical tissues; these rubber pads lie in shallow depressions on the inner surface, which are formed as a result of the pressure set up.

The photographs illustrate an extreme case in which a comparatively large bark area is affected, with the fungus penetrating to a slight depth into the wood beneath. The more numerous cases are those in which a smaller patch of cortical tissue is involved and, though the wood surface beneath is discoloured, there is no penetration of the woody tissues by the fungus.

The effects of lightning in rubber and coconut plantations are quite opposite in one respect. In rubber plantations the secondary symptoms are caused by fungi which have been long known as probable causes of specific diseases of rubber trees. On the other hand, the secondary bud-rot symptoms in Malayan coconut plantations cannot be connected up with any disease-causing fungus. *Marasmius palmivorus*, Sharples, simply accelerates defoliation and has nothing to do with the actual rotting of the bud tissues.

There is nothing unexpected in the association between lightning and the Diplodia sp. commonly found attacking rubber trees suffering from "die back." The partiality of this fungus for scorched cortical tissues has been proved (4), and this feature has been amply demonstrated in trees scorched by lightning which have been examined during the present investigation.

The treatment of the trees showing the small patches of diseased tissue at the collar is simple. The bark area affected is delimited by light scraping with a chisel or a similar instrument; when this has been accomplished, the diseased area with about one inch of surrounding healthy tissue is stripped from the wood. From the theoretical point of view, scraping the diseased bark should be avoided as much as possible, for it is quite impracticable to prevent minute traces of the scrapings falling into crevices at the base of the tree or on the soil to become mixed with the latter. If this occurs, the danger of reinfections at the collar are obvious. Reports have been obtained to show that stripping away the disease patches is very difficult in certain districts, and this may be the case but, except on very rare occasions, the writer has experienced little difficulty in carrying through the stripping operation. There is no doubt that reinfections at the collar are commonly found if scraping is undertaken, but there is little chance of reinfection if the whole of the diseased tissue is stripped away in one piece. After stripping, the diseased tissue should be destroyed as quickly as possible; it is advisable to have a container handy containing a small amount of kerosene or copper sulphate or any strong disinfectant in which the diseased tissue can be soaked prior to burning. After stripping, the exposed wood surface should be painted first with a suitable disinfectant and later covered with a permanent wound dressing; a coating of tar or of Asphaltum-Kerosene mixture are quite suitable for the purpose.

The species of Pythium isolated from the diseased cortical tissues will be reported on subsequently. The occurrence of this Pythium species which causes the claret-coloured canker at the collar of rubber trees slightly affected by lightning is difficult to explain. The difficulty might be overcome if claret-coloured bark-canker of the tapping panel was a common disease in Malaya, as it is reported to be in Ceylon. This disease of the tapping panel is rarely met with in Malaya, so this cannot be considered as a source from which the Pythium sp. would be derived. This fungus might escape notice on areas carrying a heavy cover crop, for the cover plant would provide the desirable humid conditions for growth and spread, and it may be submitted that the fungus might be present without special symptoms becoming prominent on

the cover crop. If evidence was forthcoming to support this suggestion an acceptable explanation of the observed phenomena could be provided. But in several mature areas recently found affected by lightning, where the slightly affected trees were all found to be suffering from claret-coloured bark canker at the collar, no cover crop was present, so that this suggestion cannot be accepted.

Two alternatives are available.

(a) That the organism is a soil-inhabiting fungus.

(b) That the fungus is commonly present in the interstices of the bark, where it may be able to live saprophytically for a time, and later may be washed down to the collar during heavy rains, where, under more favourable growth conditions, infection may take place.

No evidence has been obtained, as yet, to support either alternative.

Summary

1. Lightning has been proved to be of importance in the causation of disease on rubber plantations.

2. The typical effects on rubber plantations are described, and attention is specially directed to the association of claret-coloured bark canker at the collar of trees slightly affected by lightning.

Acknowledgment

The writer wishes to acknowledge the help rendered by his colleague Mr. H. Gunnery. Thanks are also tendered to Mr. G. Shelton-Agar, Kuala Lumpur, and Mr. G. C. Pringle, Klang, for assistance in connection with field observations.

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11
10
13
8
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9A
8A
8
12A
4
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1
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5
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FIG. I

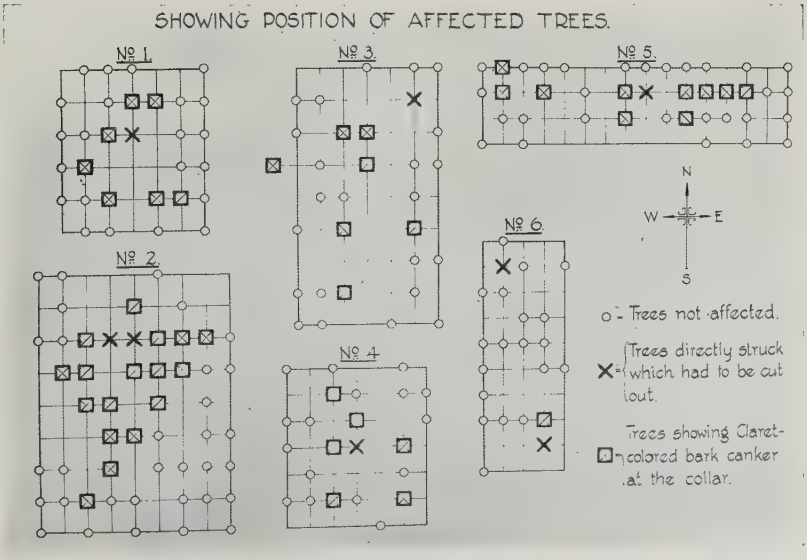
SHOWING POSITION OF AFFECTED TREES.
№ 1.
№ 3.
№ 5.
№ 2.
№ 4.
№ 6.
N
W
E
S
o - Trees not affected.
X - Trees directly struck which had to be cut out.
Trees showing Claret-colored bark canker at the collar.

FIG. II

FIG. III

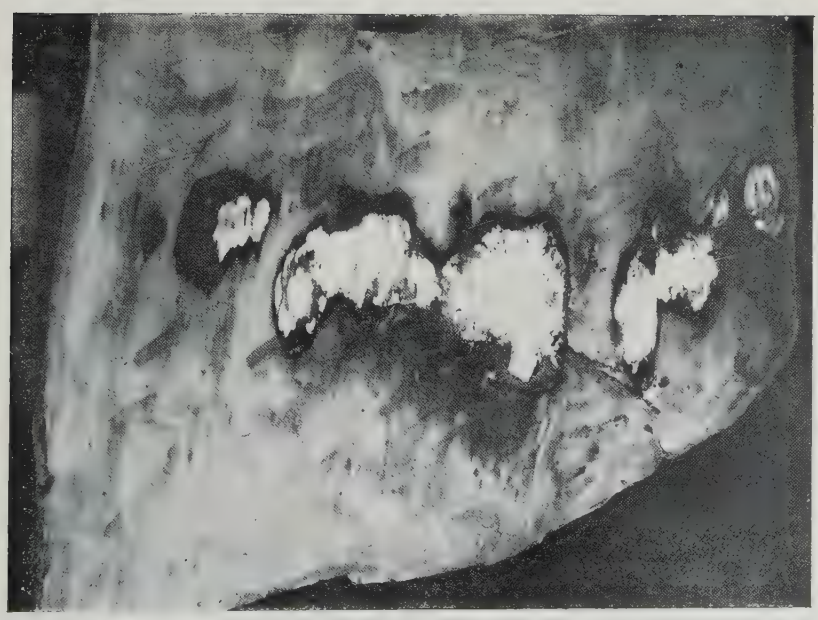

FIG. IV

A NOTE ON MANGANESE IN MALAYAN SOILS

BY

C. G. Akhurst

Introduction

Manganese occurs in almost all soils and a definite small minimum amount is found to be essential for the proper nutrition and complete development of plants. Since the amounts required by plants are exceedingly small when compared with the quantities of other essential inorganic plant foods, such as potassium, calcium, magnesium, etc., manganese is classified as one of the minor essential plant foods.

In sheet rubber, manganese may be one of the factors contributing to tackiness, and it seemed possible, therefore, that rubber trees growing on soils of high manganese content might utilise manganese in quantities sufficient to have a deleterious effect on the rubber produced from the latex. A recent investigation by Bishop and Sekar (1) has proved that tacky sheet rubber can result from the use of fungicides containing potassium permanganate, and they definitely advise against the use of such disinfectants because of the possible harmful action on the rubber.

Typical normal sheets of smoked rubber may contain 0.10 to 0.20 mgms. Mn per 100 gms. of dried rubber (i.e 0.0001 to 0.0002% manganese), whereas sheets which contain 1 to 20 mgms. Mn. per 100 gms. of dried rubber (i.e. 0.001 to 0.02% manganese) are distinctly "tacky" (2). An average figure for the manganese content of soils is given as about 0.085% Mn, and some tropical soils have been found which contain as much as 11.6% Mn (3). Table I gives the total manganese content of soils from different countries, the soils being classified as non-manganiferous, intermediate and manganiferous (4, 5, 6, 7, 8).

If any soils, carrying rubber, of the manganiferous type exist in Malaya, their high manganese content would almost certainly reflect in the amounts of manganese contained in the latex. The occurrence of manganese in Kelantan, Perak and Trengganu has been recorded and Scrivenor (9) remarks that "black oxide of manganese is of frequent occurrence in clay over limestone in tin-mines". He also records that weathered rock material from felspar contained

0.217% Mn. An examination of Malayan soils was therefore instituted for the purposes of recording their manganese contents and determining the possibility of ill effects being produced where rubber is grown on soils containing appreciable quantities of manganese.

TABLE I

Manganese in Soils (per cent.)

	Non-manganiferous	Intermediate	Manganiferous
Texas, U.S.A. ...	0.02 -0.07	0.10 -0.15	0.5
Georgia, U.S.A. ...	0.015-0.054	0.12 -0.26	0.39 -0.96
Alabama, U.S.A. ...	0.015-0.054	0.08 -0.18	2.2
Kansas, U.S.A. ...	—	0.085-0.25	0.8
Connecticut, U.S.A. ...	0.03 -0.07	—	–
Latvia. ...	0.06 -0.089	0.10 -0.27	–
Philippines. ...	—	0.14 -0.34	0.44 -0.62
Hawaii. ...	0.02 -0.10	0.14 -0.245	3.26
Australia. ...	0.005-0.032	—	—

Experimental

The determinations of manganese were made by the standard method of oxidation with periodate to permanganate and comparing the colour produced with standard permanganate solutions prepared in the same way. Total manganese was determined (the extract being an acid solution after fusing the soil with potassium bisulphate), and in some cases water soluble manganese was estimated (the aqueous extracts being obtained by means of collodion sacs).

Results

In addition to the soils in the table, a number of others were examined and about 20 of these gave figures for total manganese ranging from 0.001 to 0.005%. the remainder containing no estimable quantities of manganese.

The results (Table II) indicate that all the soils examined, with the exception of three, may be classified as non-manganiferous (0.07% Mn or less), and the three exceptions fall in the intermediate class (0.1 to 0.3% Mn). No correlation appears to exist between the manganese figures and the mechanical analyses or the *p*H values, expect that the three soils containing the largest amounts of manganese are alkaline and are all derived from limestone rocks. Under such alkaline conditions very little solution of manganese occurs as it does under the acid soil conditions which are usually common to Malayan soils. The water soluble manganese is naturally low, and from the few determinations made on selected soils, it probably does not exceed 1 or 2 p.p.m. in normal soils.

Toxicity of manganese salts to rubber seedlings

Although manganese is an essential plant food it can produce toxic effects on growing plants. Young tobacco plants in water cultures are killed by 10. p.p.m. of manganese and 1 p.p.m. is sufficient to stunt growth (6); for barley, 25 p.p.m. Mn is toxic, and sweet peas are killed by 2.5 p.p.m. Mn (7). For the purpose of determining, therefore, what toxic effects manganese has on young rubber, some seedlings (self-sown on a nearby estate) were grown in solutions of manganese sulphate. They were grown in one-litre measuring cylinders in the laboratory, 5 uniform seedlings, about 15 inches tall, being grown in each cylinder. The concentrations of manganese varied from 0.05 p.p.m. up to 100 p.p.m., with a control set.

Under the conditions of the experiment, 5 p.p.m. Mn, and less, were tolerated by the rubber plants but 10 p.p.m. and 100 p.p.m. Mn proved toxic to the seedlings. The symptoms induced in the affected plants were as follows :—After seven days, the leaves became a paler green and slightly yellow, and after 10 days the top shoot and growing tip withered and blackened; the discoloration of the leaves increased as time went on, the changes being uniform over a whole leaf; after 25 days, partial defoliation occurred and the leaves became dry and crisp and a pale yellow in colour; complete defoliation occurred in 40 days. During this time the seedlings in the other solutions remained more or less normal in appearance.

The "control" plants, which were self-grown seedlings but were subsequently grown without manganese salts in the solution, show a normal distribution of manganese, i.e. largest amounts in the leaves and least in the roots. The seedlings grown in manganese solutions have absorbed manganese to a considerable extent and the roots contain over twenty times the amount found in the leaves.

TABLE II

Manganese in Malayan Soils

Laby. No.	Geological origin of soil	Depth of soil	% Total Mn.	% Water soluble Mn.	*p*H Quinhydrone	% Sand	% Silt	% Clay
85	Chert ...	Top	0.0113					
121	(Kelantan) ...	...	0.0418					
123	(Kelantan) ...	...	0.0426			22	68	9
129	(Kelantan) ...	...	0.0171			87	8	5
144	Quartzite & Shale ...	Top	0.0194	nil				
PB. 9	Quartzite & Shale ...	Top	0.0381	0.00013	4.07	39	8	54
PB.12	Quartzite & Shale ...	Sub	0.0322		3.9	8	6	86
PB.14	Quartzite & Shale ...	Sub	0.0240	nil	4.3	22	8	70
PB.16	Quartzite & Shale ...	Sub	0.0315		4.8	22	6	72
-(a)	Dolerite ...	Top	0.0314		5.5	15	24	57
-(b)	Dolerite ...	Sub	0.0247		5.2	7	8	54
-(c)	Dolerite ...	Sub	0.0230		5.2	8	11	76
198	Raub Series ...	Top	0.0095			53	7	40
205	Raub Series ...	Sub	0.010			13	36	50
281	Raub Series ...	Top	0.0097		4.6	58	5	37
482	(Kelantan) ...	Top	0.0465	0.00005		31	25	44
483	(Kelantan) ...	Sub	0.0433			7	15	78
1017	Limestone ...	Top	0.218	nil	8.4	37	11	50
1019	Limestone ...	Sub	0.277		7.7	16	15	64
1020	Limestone ...	Sub	0.283	nil	8.0	15	15	66
1023	Granite ...	Top	0.0488	nil	7.6	69	5	24
1025	Granite ...	Sub	0.0164		4.3	49	3	39
1028	Schist ...	Sub	0.0707		7.0	36	30	33
1056	Coastal clay ...	Top	0.0141		7.0	23	12	65
1059	Coastal clay ...	Sub	0.0069		6.9	13	11	76

Some of the plants were analysed for their manganese content, the results being as follows:—

	% Manganese in ash		
	Leaves	Stems	Roots
Plants "A" 100 p.p.m. Mn.	0.82	7.83	18.3
Plants "B" 10 p.p.m. Mn.	0.38	2.91	8.7
"Control" Plants	0.125	—	0.019

Conclusions

Toxic amounts of water soluble manganese have not been found in any of the Malayan soils so far examined, but in abnormal circumstances it is possible for toxic amounts to be produced. Under reducing conditions, any manganese dioxide in the soil will tend to reduce to soluble manganous salts, thereby raising the amount of available manganese towards toxic limits. A waterlogged soil provides these reducing conditions and the poor growth of rubber which invariably results on such sites might be partly accounted for by the production of toxic quantities of manganese. It has not been possible to test soil samples from typical waterlogged areas in order to verify this point.

The combination of the low values for manganese in Malayan soils with the observation of the toxic effect of 10 p.p.m. Mn on rubber seedlings, indicates that the intake of manganese by rubber trees in quantities capable of proving detrimental to sheet rubber is extremely unlikely. It is almost certain that, where manganese occurs in any appreciable quantities, the growth and condition of the rubber trees will suffer considerably and that the quantity of latex produced will be affected before its quality is lowered.

Summary

(1) Manganese contents of a number of Malayan soils are recorded. In no case was manganese found in quantities sufficient to have detrimental effects on sheet rubber.

(2) Toxic effects of excessive amounts of manganese on rubber seedlings are described.

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REPORT

ON

DISEASES OF THE RUBBER TREE IN KEDAH

BY

R. P. N. Napper

During February 1933 the writer made an extended tour of the main rubber growing areas of the State of Kedah, visits being paid to twelve estates in the central and southern districts. The following report embodies the general observations made, and the opinions formed during the course of the tour, in relation to problems concerning the diseases of the rubber tree in Kedah. Since the tour lasted only fifteen days, and took place at a time when the weather conditions were extreme (see Section III), it is realized that some of the opinions and generalizations may require modification.

SECTION I—MAIN PROBLEMS ENCOUNTERED

The individual problems encountered have been discussed in detail in special reports written to the estates concerned. The present report is in the nature of a summary in which only general aspects will be considered.

The problems will be dealt with under the following headings:—

A. Root Diseases
B. Stem and Branch Diseases
C. Diseases of the Tapping Panel

Since the visit took place at the height of the wintering season no observations on Leaf Diseases could be made.

A. Root Diseases

The root disease problems in Kedah, in rubber areas planted directly after jungle, are of exactly the same type as exist on similar areas in other parts of Malaya.

This statement is based not merely on general observations, but on precise information the writer has been fortunate enough in obtaining from two estates in the district, which have recently

undertaken systematic tree-to-tree examination for root disease in young rubber and mature rubber respectively.

With regard to the former, the estate in question has for the past two years carried out an intensive programme of root inspection and treatment for the control of White Root Disease caused by *Fomes lignosus*. The data collected by the manager during the course of the operations have been of great value, and will be embodied shortly in a new publication on the subject of root disease control in young rubber. It may be mentioned here, however, that the information obtained on this particular estate, besides showing that the root disease complex in young areas in Kedah is of a normal type for Malaya, also confirms the discovery, made about a year ago at our Experiment Station, that, in Malaya, Red Root Disease, caused by *Ganoderma pseudoferreum*, is as inseparable from the root disease complex in stands of young rubber as it is from the root disease complex in mature areas. The disease does not cause much damage to the young stand, the loss of seedlings due to Red Root being barely one tenth of the loss caused by White Root Disease, but, if neglected, the disease often plays appalling havoc in the stand from the fifteenth year onwards, and is, in fact, one of the chief factors limiting the economic life of rubber plantations in Malaya. A severe, but by no means exceptional example of the damage caused by Red Root Disease in mature rubber is provided by the results of the root inspection carried out on the second of the estates mentioned above. The rubber on this estate is only about twenty years old, but certain fields are already infected by the disease beyond hope of treatment. In one field of 54 acres, tree-to-tree inspection revealed over 50 per cent infection, and yet all this damage might have been prevented if the disease had been detected and treated before maturity, when the cost of treatment would have made but an insignificant addition to the cost of control of White Root Disease.

Both diseases originate from jungle trees which were infected at the time of felling, and preventive treatment consists simply in discovering the offending root systems while they still retain their identity (i.e. before they rot away too far) by making routine tree-to-tree inspection in the seedling stand, and in completely eradicating these root systems from the soil. The experiments in progress on the first of the estates mentioned above indicate clearly that such treatment can be carried out efficiently, and at an economic figure, even in these days of financial difficulty, while the benefits to be derived from the treatment are incalculable.

The root disease problem is abnormal on many Kedah estates, because the present stand was not established in new jungle

clearings, but in old clearings, the soil of which had been cultivated for many years previously by Chinese and others for the production of tapioca and other crops. Quite a high percentage of the European-owned rubber areas in Kedah were established in this way on old tapioca land, and on these areas the centres of infection of both Red Root and White Root Diseases were removed by cultivation, or rotted away, before the rubber was planted, so that the incidence of root disease is practically unknown. It was striking to see the completeness of the stand on some of these areas.

The evidence obtained from the old tapioca lands offers strong confirmation of the theories which the writer* has advanced to explain the origin of root diseases on rubber estates. Briefly, these theories state that a rubber tree can only be invaded by the causal organisms of Red Root or White Root Disease if its roots are in contact with buried timber which is in the process of being rotted by one or other of these fungi. If spread of root disease by wind blown spores were of any practical significance, then the entire absence of root disease from plantations established on old cultivated land could not be explained satisfactorily.

Where previous cultivation was of short duration some root disease was observed, but it was confined chiefly to Red Root Disease, the damage done by White Root Disease being well below normal. This fact was of interest, as it supports a suggestion made by the writer* in order to account for the normal relative distributions of these two diseases in young and old plantations, viz. that *Ganoderma pseudoferreum* is a more slowly acting wood-destroying organism than is its near relative *Fomes lignosus*.

The only other root disease of economic importance which was observed was the root and collar rot caused by *Ustulina zonata*. This disease was found to be as prevalent in Kedah as in the F.M.S. and arises from the same causes, the most important of which is failure to keep the collars of rubber trees free from earth scrap. If earth scrap is allowed to accumulate at the collar over long periods, thick pads of coagulated latex of considerable area form over the bark in certain places. Beneath these pads the bark tends to become asphyxiated, and the incipient wounds so formed are particularly suitable for the development of the wound parasite *Ustulina zonata*. Periodic cleaning up of the collar of each tree will go a long way towards eliminating this type of root disease.

B. Stem and Branch Diseases

The most important stem and branch diseases in South Kedah are Pink Disease caused by *Corticium salmonicolor*, and Patch

*Annual Report, 1932, R.R.I. of Malaya, pp. 95—98

Canker caused by *Phytophthora faberi* (or some closely allied fungus).

Pink Disease

Pink Disease is one of the most important diseases in the areas visited. It is generally distributed over the whole of South Kedah, and the adjoining Selama district of North Perak, its severity varying with the rainfall. The highest infections occur on the foothills of Gunong Bintang and Gunong Bongsu, the severity of the disease falling off with increasing distance from these hills. Even in the Sungei Patani district, where the rainfall is comparatively low, the disease is more prevalent than in Selangor. Climatic factors will probably account for this state of affairs, for the climate in Kedah is more truly seasonal than the climate further south along the western coast of the Peninsula, and the greater intensity of the wet season probably enables the disease to accomplish more damage during its period of active growth in Kedah than it does in Selangor, while the ability of the fungus to withstand drought counteracts the compensating effect of the more intense dry season which Kedah enjoys.

Continuous records of the incidence of Pink Disease for several years have been obtained from an estate on the Perak side of Gunong Bintang. These records show, in a striking fashion, that the disease in that district is most severe on young trees between the ages of three and seven years, and falls off towards the tenth year. It was noticed, on one area similarly situated on the Kedah side of the mountain, that the disease can persist in a destructive manner up to the fifteenth or twentieth year. There was some evidence, however, in this case, that the persistence was due to neglect, and the impression was obtained that, given normal and conscientious treatment, the attack would have passed its peak by the tenth year.

One of the most serious features of Pink Disease noticed in South Kedah was its tendency to pollard trees, even large trees up to twenty years old, by ringing them at ten to twenty feet from the ground. This type of damage, again, seemed to be connected with neglect of treatment.

Systematic treatment of the disease was found to be general in Kedah, although in these days of economy the frequency of treatment is often insufficient to provide adequate control. Plain tar is most frequently used in treating the disease, and gives good results. A number of complaints were received, however, about the recent variability of even the best grades of tar, some samples being difficult to apply, and others not adhering properly to the infected surfaces. A tar of unknown composition is a dangerous

weapon in the hands of coolies, and in order to prevent the possibility of wholesale bark burning a general change-over to the Asphalt-Kerosene mixture recommended by the Institute was advocated. This mixture has a known composition, and can be brought to any consistency which is desired. Moreover, its cost is only slightly higher than that of tar and, if Solar Oil is used instead of kerosene, the cost is even below that of good tar. If Solar Oil is introduced into the mixture the question of variability crops up again, but the mixture still remains a more satisfactory one than tar of doubtful composition and, if tried out first on healthy bark, may be used with confidence.

Satisfactory control of Pink Disease in seedling rubber was reported from one estate by the use of weak solutions (5 per cent in water) of Brunolinum Plantarium, mixed with a colouring agent to aid supervision.

Patch Canker

Of the stem and branch diseases in South Kedah, Patch Canker ranks next to Pink Disease in importance. Its distribution is similar to that of Pink Disease, being obviously more severe in districts of higher rainfall. The fact that the disease is more prevalent in South Kedah than in the neighbourhood of Kuala Lumpur can probably be explained along the lines followed in discussing Pink Disease, but little is known of the manner in which the causal fungus overwinters during the dry season in Kedah, for the bark cankers caused by the disease are very susceptible to drought, and are usually sterilized completely during the wintering period.

Infection normally takes place on the main stem within five or six feet from the ground. It does not usually occur on trees under five years of age, but specimens have recently been received from one of the estates visited which may possibly represent Patch Canker on very young material. When the disease occurs on young trees, the patches appear close to the ground, and on budgrafted material this position coincides with the junction of stock and scion. The disease under these circumstances has the appearances of an ailment peculiar to budgrafts, and it was even suggested that this might be further evidence of that "inherent weakness" which some planters feel convinced must necessarily exist in budgrafted trees. No conclusive opinion on the matter was formed, but there certainly exists a possibility that the disease may be influenced by the operation of budgrafting while being independent of any "inherent weakness" on the part of the budded tree, for the kink in the stem at the "elephant foot" may provide a ledge

on which spores and moisture can lodge and so bring about local infection.

In connection with Patch Canker a special problem arose during the visit which will be dealt with in Section II of this report.

C. Diseases of the Tapping Panel

The most important panel diseases encountered were Black Stripe caused by a fungus of the Phytophthora type, Mouldy Rot caused by *Sphaeronema fimbriatum*, and Brown Bast. Sun scorch of the newly tapped bark was also met with occasionally.

Black Stripe

Black Stripe is prevalent in South Kedah, and has a distribution practically identical with that of Patch Canker. This is not surprising when it is remembered that these two diseases are caused by two very closely allied fungi.

The disease appears chiefly during the wet season, and its mark is left on infected trees as a broad band of wounds stretching across the strip of bark tapped during the months of October to December. Considering the prevalence of the disease the extent of the damage observed was small, and this must be attributed to the fact that the disease is treated promptly and efficiently as soon as it is detected. When treatment is neglected, the disease often spreads into the untapped cortex below the tapping cut, the resultant damage to the panel being frequently irreparable; but of the many hundreds of infected trees examined during the tour, only one was permanently disfigured in this way, and this tree had in fact been overlooked during treatment. The usual type of damage observed was a band of wounds, often not much more serious than tapping wounds, disfiguring the area of the panel tapped over during the wettest months of the year. In February, when the panels were examined, the progress of the fungus had been entirely arrested by the drought, and the wounds were already beginning to heal. It is possible that a little local research on strengths, and rates of application of various fungicides, might enable even this small amount of damage to be avoided.

Mouldy Rot

This ubiquitous disease was well established in kampongs in the Kulim district at least as early as 1930, but it is interesting to note that it has not yet been reported as causing serious damage on European estates in South Kedah. From the information obtained, the opinion was formed that the disease does not flourish so easily in the climate of Kedah as it does in the

climate of the rubber-growing areas further south; probably the disease is too severely checked by the intense drought during the wintering period in Kedah to be able to develop epidemic proportions in normally planted estate rubber.

These opinions were formed after investigating the only instance of attack on normal estate rubber which was brought to notice. The estate on which the attack occurred has an experimental area in which an investigation of the effect of planting density on yield is being carried out. Mouldy Rot has been firmly established in the closely planted plots of this area for the past three years, and appears to flourish there, but, so far, the spread of infection beyond the limits of the experimental area has been inconsiderable.

An interesting feature of this particular attack was that the application of an Asphalt-Kerosene mixture to infected panels, as soon as the first signs of the mould appear, has proved successful in entirely preventing bark loss.

The bark damage observed on untreated panels closely resembled the damage caused by Black Stripe. It is possible that these two diseases have been confused to some extent in the past, and that some estates which have reported attacks by Black Stripe have really been suffering from a mild attack of Mouldy Rot. The significance of this possibility will be discussed in Section II. It is unlikely, however, that a heavy attack by Mouldy Rot would be mistaken for Black Stripe, for the appearance of the mould developing on infected tissues is very characteristic and can be seen in dry weather as well as in wet. In fact, even during the severe drought which was in progress at the time of the visit, the causal fungus of Mouldy Rot was very easy to identify, and was even then observed to be causing new infections.

With regard to the existence of other infectious panel diseases in Kedah, it was suggested to the writer, on two different occasions, that certain panel infections might be due to species of Fusarium, similar to the fungus which has recently been reported as causing a panel disease in Java. While there is little doubt that species of Fusarium have frequently been seen on infected panels in Kedah, this does not necessarily mean that they have caused direct parasitic attack on the newly tapped bark. Species of this genus are everywhere of frequent occurrence as secondary organisms growing on dead or moribund plant tissues, and can almost invariably be found contaminating panels damaged by sun scorch or attacked by diseases such as Mouldy Rot. With regard to the two instances brought to the notice of the writer in Kedah the first was probably a case of Black Stripe infection, and the second undoubtedly an attack of Mouldy Rot.

Brown Bast

Brown Bast is of common occurrence in Kedah, a fact which appeared to be closely associated with the heavy tapping systems which have been in vogue in the past. It has been the custom to tap alternate daily for very long periods, even up to ten years, without rest, and the development of Brown Bast under such circumstances is not difficult to explain. More conservative systems are now rapidly becoming popular, and, with their adoption, a considerable reduction in the incidence of Brown Bast will probably be noticed.

Sun Scorch

Wounds on the tapping panels caused by sun scorch of the delicate, newly tapped bark during the wintering period, were seen on a few occasions; but, for a district which experiences such a very sharp wintering, when the whole stand is practically leafless and the panels exposed to a fiercely hot sun for two or three weeks in succession, the amount of damage observed was surprisingly small. Perhaps more would have been noticeable three or four weeks later.

SECTION II—SPECIAL PROBLEMS WHICH MAY NEED FURTHER INVESTIGATION

Most of the pathological problems encountered in Kedah differed to a greater or less degree from the corresponding problems in the rubber-growing areas further south, and some seemed to stand in need of special local investigation.

Among the latter the two following problems appeared most pressing:—

Branch Cankers

When discussing branch cankers, a certain planter voiced the opinion that many of the branch cankers on his estate were caused by Patch Canker and not by Pink Disease. During the wintering period, when the causal organisms are dormant, the cankers associated with these two diseases are very similar, and the writer was therefore unable to give an opinion on the matter at the time, but has raised the point with other planters in the same district, and it is hoped that the matter will be cleared up when a consensus of opinion is obtainable.

The common view is that Patch Canker does not occur except on the main trunk, and that cankers in the forks and branches are invariably due to Pink Disease. There appears to be no

adequate reason, however, why Patch Canker should be confined to the trunk to the exclusion of branch infection (unless infection takes place solely by the up-splashing of contaminated soil water during heavy storms, which is unlikely when it is remembered that the causal organism gives rise to leaf and fruit infection in some countries), and if it really happens that branch cankers are often due to this disease and not to Pink Disease, the fact will have an important bearing on the treatment of Pink Disease.

Both diseases react in a similar way to the influence of weather conditions, but with this important difference: whereas, under the conditions obtaining in Kedah, the drought during wintering almost completely checks Patch Canker and sterilizes infected tissues, Pink Disease is more resistant to drought, and the cankers caused by this disease often recommence activity when the rains return.

It is of the utmost importance, therefore, to keep Pink Disease under rigid control in an area where conditions during certain periods of the year are so favourable for its development. In the absence of control, cankers once established may continue their activity from season to season, rapidly ringing the tree at the points of infection, and causing serious damage. Patch Canker cankers, on the other hand, usually exist for one season only, being sterilized during the dry weather and rapidly healing over. Treatment of such cankers from the point of view of the general health of the tree is probably, therefore, waste of effort, since such an excellent means of control is provided by the weather. Treatment of Patch Canker when it appears on the trunk is, of course, of vital importance from the planters' point of view, as it is necessary to minimise the damage done by the disease to the tapping panel, and to ensure that the wounds which are formed shall heal as rapidly and as evenly as possible.

If, therefore, it is shown, as it might well be, that the branch cankers so common in certain parts of Kedah and North Perak are frequently due to Patch Canker, considerable saving may sometimes be made under the heading of "Pink Disease Control". It is perhaps a significant fact that certain planters in Kedah voiced the opinion that an enormous amount of money is continually being wasted on the control of Pink Disease, because, even if left untreated, the actual damage done is small; while others contended with equal conviction that, in their experience, neglect of Pink Disease treatment is a very dangerous policy. If two types of branch canker exist, these apparently conflicting opinions might be reconciled.

There are certain risks to be taken if the treatment of Patch Canker in the branches (if it exists) is abandoned. In the first

place, such a policy may lead to an increasing incidence of the disease on the tapping surfaces, and in the second place it may give rise to an outbreak of leaf and fruit disease since Patch Canker is caused by a species of Phytophthora (or a closely allied genus) which has been shown to cause secondary leaf fall and fruit rot in Ceylon. These risks could be evaluated by means of simple experiments. Increase in incidence of the disease on the tapping panel through neglect of treatment of branch cankers is not unlikely, but the risk of secondary leaf fall is small. Both Black Stripe and Patch Canker are caused by species of Phytophthora which have been identified with serious secondary leaf fall in other countries with a more typical monsoon climate than that of Malaya, but although both diseases have been well established for many years in Kedah, where the climate is more profoundly influenced by the monsoons than it is in other rubber growing districts of Malaya, secondary leaf fall due to Phytophthora attack has never yet developed there to any visible extent.

Panel Diseases

If, as is suggested in Section I C, the Black Stripe and Mouldy Rot diseases have been confused in the past, the latter disease may be more widely distributed and economically more important in Kedah than has hitherto been realized. In view of the recent apparent increase in the severity of the Mouldy Rot disease in the south, it will be in the interest of the planting community in Kedah to determine with greater accuracy the local status of the disease, and the amount of increase in infection, if any, which has occurred in the district during the past few years.

SECTION III—OBSERVATIONS ON SOME TOPICS OF GENERAL INTEREST

Climate

The climate in Kedah differs considerably from the climate in the central and southern rubber growing districts of Malaya. It is influenced to a much more marked degree by the monsoons, having a sharper, and more intensely dry and hot wintering period, and a greater concentration of rainfall in the "wet season."

As has been shown above, these climatic differences have a profound effect upon the course of plant diseases, giving rise to problems which differ widely from the corresponding problems in the main rubber growing areas in central and southern Malaya, where the climate is more uniform.

It is the extremes of climate in Kedah, and not the average weather conditions, which are effective in modifying the course of disease, for the latter differ but little from those of the main rubber growing areas of the country, and the powerful modifying effects of the extremes of drought or rainfall, experienced at the dry or wet seasons respectively, are apt to pass unnoticed during a short visit unless the visit happens to coincide with the height of one or other of these seasons.

It is most important, however, that the significance of these effects should be realised before an attempt is made to deal with disease problems in Kedah according to methods which have become established in regions of more uniform climate, such as is experienced, for instance, in Selangor where most of the investigational work has been carried out.

It was fortunate, therefore, that the writer's visit to Kedah coincided with the wintering season, when the contrast between the climate of Kedah and the climate of southern Malaya is more striking than at any other period of the year. As a matter of fact, the drought experienced before and during the visit was of exceptional intensity, even for Kedah. When the tour began at Baling, on February 6th, no rain had fallen there for more than thirty days, and no rain occurred en route until nearly a fortnight later. The visit appeared at first to be most inopportune. The intense drought in progress had brought fungal activity to a standstill (even root disease fungi being dry and difficult to identify) and it was feared that on this account the tour might not be a success. Fortunately, however, these fears proved to be groundless, for although serious difficulties were encountered in handling certain individual problems, the drought interfered surprisingly little with advisory work in general and, as has been indicated above, offered exceptional opportunities for observing and appreciating the peculiar climatic conditions of the district, and their effect upon rubber tree diseases.

As these observations continued during the course of the tour, it became more and more apparent that methods of plant disease control devised in the central and southern districts of Malaya are not necessarily applicable in Kedah without modification. Before such methods can be employed for the control of plant diseases in Kedah the climatic conditions peculiar to the district must be given careful consideration. This dictum applies more especially to stem, branch, leaf and panel diseases, root diseases being less easily influenced by the vagaries of the weather.

Superimposed upon the influence of the monsoons are the influences of the large mountain masses which govern the magnitude of local precipitation. In central and south Kedah the chief topographical features influencing climate are Gunong Jerai

(Kedah Peak), Gunong Bintang and Gunong Bongsu (with Bukit Sungei Ular).

Little information was obtained with regard to Kedah Peak, but its effects on local climate did not appear to extend far out into the surrounding plain. The other two mountain masses, however, have a widespread effect on rainfall on rubber estates in their vicinity, and it is around the foothills of these mountains that most of the trouble is experienced with fungal diseases of the aerial portions of the tree.

Although Gunong Bongsu is only an insignificant hill compared with the mighty bulk of Bintang, yet its effect on local rubber cultivation is more intense than that of Gunong Bintang, as the plantations on its slopes reach much nearer to the centre of the zone of high rainfall than do the plantations on the slopes of the latter mountain. It is on the foothills of Gunong Bongsu that estate rainfall figures reach their maximum, one such estate registering 175 inches in 1932 (an abnormal year in that particular district it is true).

Gunong Bongsu is, in fact, the northern extremity of a belt of high rainfall which extends northward from the Taiping Hills, crossing an area of rubber cultivation at Selama (Perak), and creating conditions there similar to the conditions on the slopes of Gunong Bongsu over the border. In Kedah, the effects of Gunong Bongsu on the incidence of disease are felt in Selama (Kedah), Serdang, Terap, Sungei Ular, Karangan and Mahang, merging into the Gunong Bintang effects on the east, and dying away to the west and north into the plains beyond the foothills.

Yields, Costs and Condition of Cultivation

It was of interest to note the high level of the yields and the low level of the costs on the properties visited, and the high general level of cultivation which has been maintained in spite of the difficulties of the present financial situation.

Budgrafting

Budgrafted rubber is superseding seedling rubber in all new plantings, and there are large budgrafted areas already in bearing and giving excellent yields.

Forestry Methods

Considerable critical interest was shown in the "forestry system" of rubber cultivation, and the effects of the recent "forestry" campaign on plantation practice were evident in many quarters. The general feeling towards the system was slightly

antagonistic, the dislike not being entirely due to prejudice (in spite of the somewhat cynical attitude often assumed when referring to the system) but to a realization of the fact that the scheme may be excellent in theory but that it will be expensive to put into practice, and will inevitably lead to considerable trouble through the increase in incidence of stem, branch and panel diseases.

Summary

1. A general report is made on an extended tour of the main rubber growing areas of the State of Kedah which took place during February 1933.

2. The main problems of pathological interest encountered during the tour are discussed, particularly in relation to their dependence on local climatic conditions.

3. Certain of these problems, which appear to be peculiar to the district, and may need special local investigation, are considered in some detail.

4. Observations are made on various topics of general interest.

MALAYAN PATENTS RELATING TO RUBBER

PART I

BY

J. L. WILTSHIRE

The study of patents relating to rubber is pursued at the Rubber Research Institute for two reasons, (1) the obvious necessity of being able to supply information to the industry and to apply this to the internal work of the Institute, (2) to facilitate the work of examining new claims, which frequently falls on the Director and on the Chemical Division. It may appear strange, but is certainly true that, even to residents in Malaya, information about patents granted by the F.M.S. and by the S.S. Governments is more difficult of access than any of the other patents normally of interest i.e. English, French, German, Italian and American, since no abstracts are published.

The position of patent law in this country is best understood by reference to the original F.M.S. Enactment of 1914 and the subsequent rules, orders and amendments. It must be understood that these are here discussed from the point of view of the technical man who may have to examine, use or oppose patents and not from the legal standpoint. Attention is confined mainly to the F.M.S. but the arrangements in the S.S. are similar although not identical.

The original Enactment referred to above is F.M.S. No. 19 of 1914 and is entitled "An Enactment to make better provision for the grant of Exclusive Privileges in respect of Inventions." This Enactment cancels the patent regulations of the constituent States of the Federation passed in 1896 and 1897 and is substantially the Enactment now in force. It is to be found in the collected "Laws of the F.M.S." and in the Edition in the library of this Institute i.e. the 1877-1920 Edition, it occurs on page 597 of Volume II.

Later amendments and orders made by the Executive are to be found in the following gazette notifications :—

Nos. 430 and 1560 of 1915; No. 922 of 1918;
Nos. 2363 and 4728 of 1922; No. 2424 of 1923;
No. 2599 of 1925; No. 5213 of 1928.

From the present point of view these are of little practical importance and refer mainly to alterations in forms and fees. The most important amendment is Enactment No. 2 of 1925 which extends the life of the grant from fourteen to sixteen years provided that the appropriate renewal fee is paid at the end of the seventh year.

It is not within our province to discuss the legal aspect of this Enactment but, since it is largely based on English patent law it may

be of interest to note that the English law arises from a special exception to the Statute of Monopolies of 1623. This statute abolished "all grievous and inconvenient monopolies except grants of privileges, for the sole working or making of any new manner of manufactures within the realm, to the true and first inventor of such manufactures which others at the time of making shall not use, so also they be not contrary to the law nor mischievous to the State by raising the prices of commodities at home or hurt of trade or generally inconvenient." The proviso attached to this exception is of the utmost importance. It appears to be frequently forgotten that patents are not granted primarily to give a manufacturer a monopoly in the selling of any product but to ensure to the inventor a reasonable reward for his inventive ingenuity. The holder of a patent who does not satisfy the demand for the patented article or who will not grant licences on reasonable terms is liable for an action for revocation of the patent or for the granting of compulsory licences on terms dictated by the court.

Our recent experience has shown us that many individuals who devote their attention to the development and improvement of the methods of treating rubber and its product do not appreciate the essential characters of a patentable invention. We cannot summarise the patent laws but it is possible to state certain basic principles on which the laws ultimately depend.

Patents are only granted to cover "a manner of manufacture." A principle or a formula are not patentable and a product can only be protected by covering the method of manufacturing it. Griffiths in his "Patent Law and Practice" (1923) gives the following characteristic features of a manner of manufacture:

(1) It is essentially an operation on some selected matter.
(2) The operation is an artificial one.
(3) The operation results in a product having a definite useful property or a collocation of definite useful properties.
(4) The product is a vendible body.

The second essential of a patentable invention is that it should possess novelty. This means that it should not previously have been known, used or described in public. It is important to remember that the word "public" is not to be construed in its widest sense and that it is necessary for the invention to be novel—not to the man in the street—but to a person versed in that particular art, science or manufacture. Novelty also implies a certain degree of inventive ingenuity and, if an invention is a mere natural development of any art or manufacture, it may be found invalid when submitted to a court of law.

The question of the absolute novelty of an invention—i.e. the question of whether the manner of manufacture described has or has

not been used before—is comparatively simple and depends mainly on a knowledge of the industry involved and a careful study of published literature. The question of inventive ingenuity is much more difficult to decide and, in fact, is probably the most difficult of all questions arising from patent practice. It most frequently arises from the application of an old idea to a new end or from the combination of two old ideas to serve a new purpose. Here again it must be remembered that the inventive ingenuity involved in any adaptation of old devices will be far less apparent to an expert than to a person not versed in the particular art. It is the expert's point of view that is decisive since, on the issue of inventive ingenuity, the court always considers the opinion of persons who are acquainted with the state of knowledge in the art at the date of the patent.

The third essential is utility and this is, to a large extent, covered by the previous statement that a manner of manufacture must give a vendible product.

The granting of a patent is no proof of its validity; proof can only be obtained by litigation in the law courts. If a grantee considers his rights are being infringed he may proceed by a civil suit. This exposes the patent to a very thorough examination since the alleged infringer may either attempt to prove the patent invalid or wrongly granted or may claim that his operations are not infringements of the patent concerned. Any manufacturer who thinks that his rights are interfered with by the grant of any particular patent and the exercise of exclusive privileges may proceed either by a suit for revocation or for grant of compulsory licence or may continue with the manufacture himself and await infringement proceedings from the grantee. The precise conditions under which such proceedings may be instituted are defined in the relevant enactments and the proper course to be followed in any particular instance must be the subject of legal advice.

It must be pointed out that the examination of every application for a grant which is carried out by, or on behalf of the Government is only a partial protection of the public. In this country the public has an additional period of two months in which to lodge protests or opposition. If no opposition is entered then the grant is made and, in the case of a wrongly granted patent, the offended members of the public have no alternative but litigation.

The most marked difference between patent practice in the United Kingdom and in Malaya lies in the degree of publicity given to the terms of the specification. Effective publication of a specification achieves two purposes (1) it protects the inventor by advertising the fact that he has developed a new manner of manufacture (2) it benefits the public by adding the new knowledge included in the specification to the general knowledge of the particular art or science.

In England effective publication is secured by the periodical issue of the Patent Office Journal which gives abridged specifications of all patents accepted and the titles of all patents open to inspection before acceptance. Publication is still further improved by the fact that all the technical journals reprint the details of the patents of interest to their own readers. Thus the Bureau of Chemical Abstracts publishes weekly the details of patents relating to all chemical manufactures. Similarly the engineers, the petroleum technologists and the rubber manufacturers all have regular information about patents which may affect their work. Publication is effective and there is no reasonable excuse for ignorance of the acceptance of any patent. If further information is required, when the abstract or title has been published, it is a simple matter to obtain unabridged copies. Photostat copies of specifications open to inspection before acceptance are available at a cost of eight pence per page. Printed copies of complete specifications accepted are available at a cost of one shilling each.

The position in Malaya is very different and publication is little more than a legal fiction. The Enactment requires that the *titles* of specifications accepted shall be published in every issue of the Gazette for two months from the date of acceptance and that, immediately on acceptance, the specification and drawings shall be open to public inspection. The register and files are open to inspection at a charge of fifty cents. Copies of specifications in the F.M.S. may be obtained at a charge of $0.50 per hundred words and in the S.S. for the cost of copying. As an example it may be mentioned that when it became necessary to obtain a copy of a Straits patent the charge was six dollars. The only information available, without special reference to the Government office concerned, is a number of titles of specifications accepted, scattered in various issues of the Gazette. In the S.S. the actual grant of privileges is also notified in the Gazette but this is not the practice in the F.M.S. Unfortunately many of the earlier titles give little or no indication of the nature of the invention and an applicant for a patent has the choice of a personal search in the offices at Kuala Lumpur *and* Singapore or a problematical selection of titles that may be relevant to his invention and a request that these specifications should be copied which involves considerable expense. In the F.M.S. it is also necessary to enquire whether the acceptance of any particular specification was, in fact, followed by a grant of privileges. The public has to pay heavily for finding out what it is not allowed to patent or to practise. In view of the close connection between the Federation and the Colony a simple and a useful reform would be the filing of F.M.S. grants in Singapore and S.S. grants in Kuala Lumpur.

Apart from the protection afforded to an inventor by an F.M.S. or S.S. grant of exclusive privileges, holders of United Kingdom patents can extend the validity of such patents to these States by simple registration. The registration must be effected within three years of the United Kingdom grant and expires with the original. Notifications of such acceptances are published *once* in the Gazette and since British Patent numbers are given it is a simple matter to obtain full information by reference to the appropriate technical journals.

It has been found necessary for the proper functioning of the Institute to have available a list of the patents relative to rubber granted in Malaya, such a list comprising both original grants and British Patent registrations in the F.M.S. and the Colony. This list has been compiled to the end of 1932 and, in view of the difficulty of obtaining information, is now published in the hope that it may be of general use to the rubber industry. Many of the patents in this list have lapsed through non-payment of renewal fees or through completion of their full term. These patents are still of importance since they may represent a bar to the patenting of devices which are thought by their inventors to be new.

The list is divided into five sections as under :—

Part I. F.M.S. Grants of Exclusive Privileges 1914-1932

Part II. Registration of U.K. or other British Patents in F.M.S. 1914-1932.

Part III. S.S. Grants of Exclusive Privileges 1914-1932.

Part IV. Registration of U.K. or other British patents in S.S. 1914-1925.

Part V. Registration of U.K. or other British patents in S.S. 1925-1932.

The details listed in Parts I and II are from the register of grants kept by the Commissioner of Trade and Customs in Kuala Lumpur. The specifications are filed in the same office and may be inspected for a charge of 50 cents each. Parts III, IV and V are taken from the registers in the Colonial Secretary's office in Singapore. Until 1925 all U.K. patents registered in the Straits Settlements are included in the main register of specifications filed and are designated by the specification number. From 1925 onwards a separate register of such patents has been kept and a separate numbering system is in use. Specifications may be inspected on payment of a small fee. It was not possible to make a list of the grants made in the Straits Settlements prior to 1914.

The more important specifications have been abstracted and form another paper which it is intended to publish in the next issue of the Journal. Specifications which have been abstracted are marked in the following tables by an asterisk.

Part I. F.M.S. Grants of Exclusive Privileges 1914-1932

Year	Number of Grant	Name of Grantee	Title of Invention
1914	1	Hendrie ...	Latex cup
	2	Reid ...	Spraying latex on drum for coagulation
	3	Duncan ...	Improvements in coagulation
1915	5	Shelton Agar	Machine for coagulating and curing
	7	Ferdinand ...	Latex cup
	8	Evans ...	Machine for washing and milling lower grades
	9	Mailer ...	Latex spout
	10	Macnab ...	Latex spout
	11	MacLennan ...	Machine for separating bark from naturally coagulated rubber
	12	Menzies ...	Latex spout
	13	Eaton and Grantham	Improved process for coagulation
	15	Shelton Agar	Patent rolling machine
	17	Ilcken and Down	Apparatus for manufacture of rubber
1916	19	Davidson ...	Improvements in coagulation
	20	Davidson ...	do.
	21	Davidson ...	do.
	23	Carbos ...	Improvements in coagulation
	24	Nash ...	Tapping knife with removable blades
	27	Cardwell Quinn	Apparatus for smoking
	28	Menzies ...	Improved latex cup
	31	Thomas and Maude	Improvements in coagulation
	32	Evans ...	Producing smoke, cleaning smoke and arresting sparks
	33	Harris ...	Division plate for coagulating tanks
	34	Weguelin ...	Latex spout

Year	Number of Grant	Name of Grantee	Title of Invention
1916	35	Kerbosch ...	Apparatus for coagulating
	38	Wickham ...	Apparatus for treating latex
	39	Davidson ...	Improvements in the manufacture of rubber
	40	Davidson ...	do.
	41	Davidson ...	do.
	43	Addition to No. 8	In name of F. E. Co. (Machine for washing and milling lower grades)
	44	Hall and Paynter	Latex spout
1917	49	Whiting ...	Latex spout
	50	Alexander ...	Apparatus for readily indicating bark consumption
	51	Ilcken and Down	Improvements in chemical process for manufacture of rubber
	52	do.	Improvements in process for purifying lower grades
	56	Ash ...	Rain shields for tapping cuts
	61	Khoo Kim Lian	Improved tapping knife
	62	Sawh ...	Improved cup holder
	65	Wickrama ...	Improved tapping knife
	70	Jarvis ...	Pressure machine for baling
	72	Wardrop and Steven	Scrap washer
1918	73	Holt ...	Crepe folder
	74	Holt ...	do.
	76	Ilcken and Down	Treatment of raw and scrap rubber
	77	Jarvis ...	Pressure machine for packing
	80	Kwa Siew Tee	Tapping knife
	82	Claessen ...	Utilising bark shavings
	84	Gibson ...	Pressure machine for packing
	87	Rubber Patents Ltd.	Process for obtaining maximum yield

Year	Number of Grant	Name of Grantee	Title of Invention
1918	88	Black and Simpson	Baling press
	90	Bailey ...	do.
	94	Wilkins and Cameron	Rain-shields for tapping cuts
1919	98	Keller ...	Brown bast scraper
	99	Maclean ...	Waterproof tapping cover
	100	General Rubber Co.	Improvements in apparatus for treating latex
	101	do.	Improvements in coagulum
	102	do.	Improvements in process including preparation for vulcanisation
	103	do.	Improvements in process for treating latex and products*
	104	do.	Improvements in manufacture of adhesive rubber composition
	105	do.	Improvement in process for treating latex
	106	do.	do.
	107	do.	Improvements in process for separating rubber from latex
	108	do.	Improvements in process for treating coagulum
	109	do.	Improvements in baling of rubber
	110	do.	Improvements in rubber compositions
	111	do.	Improvements in coagulum and preparation for vulcanisation*
	112	do.	Improvements in treatment of scrap
	115	Sime ...	Latex cup
	132	Fisher ...	Rubber press
	136	Hayley ...	Improved flexible wrapping
	138	Curran ...	Improved press
1920	148	Lintner & Co.	Process for coagulating latex
	150	Foh ...	Cup hanger
	160	Stephen ...	Scrap washer

Year	Number of Grant	Name of Grantee	Title of Invention
1920	162	Fisher ...	Latex strainer
	163	Simpson ...	Rainproof tapping cover
	171	Fish ...	Automatic rubber standardiser
	188	Hopkinson ...	Process for treating rubber latex *
	189	McIver ...	Combined spout and hanger
	191	Gjorup ...	Self-folding case for rubber
	193	Lake ...	Process for handling and treating latex
	194	Hopkinson ...	Rubber obtained by finely spraying latex, drying and compacting *
	202	Brown ...	Combined spout and hanger
1921	214	Davidson ...	Improvements in treatment of freshly coagulated rubber
	215	Laub ...	Manufacture from latex of coagulum which can be vulcanised immediately after drying and washing and which includes ingredients imparting specific properties to vulcanised rubber *
	216	do. ...	do. *
	218	Arisaka ...	Packing or preserving rubber
	223	Peachey ...	Process for vulcanisation of caoutchouc *
	224	Latham ...	Combined spout and hanger
	226	Randell ...	Cup holder
	241	Caulfield ...	Method of affixing rubber to paving blocks*
	243	S. Anon. des Caout. de Padang	Rolling freshly coagulated rubber.
	247	Peachey ...	Process for vulcanisation of caoutchouc *
	249	Hodges ...	Steam cavity-mould vulcaniser
	252	Taté ...	Non-inflammable rubber solution

Year	Number of Grant	Name of Grantee	Title of Invention
1921	253	Sayers ...	Improved pail for latex collection
	255	Roa ...	Improved apparatus for treating latex
1922	256	Schidrowitz ...	Improvements in manufacture of rubber*
	261	Barns ...	Re-inforced rubber road traffic surface*
	266	Davidson ...	Treatment of freshly coagulated rubber
	270	Hopkinson ...	Fabrication of rubber and filamentary material*
	276	General Rubber Co.	Improved process for treating latex*
	277	Stothard ...	Improvements in methods and apparatus for tapping and collecting
	283	Walker ...	Machine for cutting rubber*
	296	Marshall ...	Vulcanisation process for manufacture of high pressure expanded vulcanised rubber
1923	317	S. Anon. des Caoutchoucs de Padang	Rolling freshly coagulated rubber
	321	Westendorp ...	Protecting tapping cut from rain
	332	Thomas ...	"The Tappers Delight"
	334	Jeffrey & Wilkinson	Process of conversion of latex of any S. G. into non-oxidisable rubber composition such as tiles, mats and floor covers*
	335	Parry Davis	"Multex" (No details)
	336	do.	"Mother of latex" (No details)
1924	349	Russell ...	Improvement in vulcanisation of rubber
	356	Hoare ...	Improvements in manufacture of sheet rubber
	359	General Rubber Co.	Process and apparatus for drying coagulable liquids *
	363	Hatfield ...	Instantaneous determination of D. R. C. in buckets
	370	General Rubber Co.	Apparatus for drying rubber latex*
	373	Anode Rubber Co.	Immediate production of mechanically unworked rubber from latex*
	374	do.	Immediate production of rubber sheet and moulded articles*
	376	Parry Davis	Condensation of rubber latex vulcanised or unvulcanised *

Year	Number of Grant	Name of Grantee	Title of Invention
1924	380	Wilkinson ...	Manufacture of rubber composition from rubber latex *
	383	Wright ...	Automatic rubber mill
	408	Percival ...	Apparatus for use in collecting latex
	410	Hopkinson ...	Process and apparatus for obtaining rubber from latex *
	411	Bamber ...	Preparation of crude dipentenes from rubber *
	419	Stutchbury & Hauser	Improvements in manufacture of caoutchouc
	421	Niblock ...	Scrap washer
1925	429	General Rubber Co.	Improvements in manufacture of raw rubber *
	430	do.	Improved process for drying latex
	449	Evans ...	Partitions for coagulating tank
	450	Naugatuck Chemical Co.	Improvements in manufacture of rubber-containing mixtures *
	453	Anode Rubber Co.	Improvements in manufacture of rubber goods from emulsions *
	454	do.	do. *
	457	K. D. P. ...	Process and apparatus for concentrating latex *
	464	Van der Mark & Kremer	Manufacturing objects from unvulcanised rubber
1926	469	Laub ...	Rain shields for trees
	475	Kendal & Graham ...	Process of cold vulcanisation of latex *
	490	Malcolm Watson	Improvements in collection of latex
	498	General Rubber Co.	Preserving latex and products therefrom *
1927	506	Anode Rubber Co.	Improvements in manufacture of rubber goods from dispersions by electrophoretic methods *
	507	General Rubber Co.	Apparatus for drying rubber latex *
	519	Wilkinson ...	Manufacture of rubber from latex *
	523	Naugatuck Chemical Co.	Improvements in method of treating latex*
1928	527	Dunlop Co. ...	Improvements in manufacture of rubber articles *

Year	Number of Grant	Name of Grantee	Title of Invention
1928	529	Dunlop Co. ...	Improvements in manufacture of rubber articles *
	530	do.	Producing rubber goods direct from latex*
	533	Rubber Electro-deposition Patents Ltd.	Improvements in production of rubber*
	536	Singhan ...	Improvements in art of concentrating latex (REVOKED)*
	537	U. S. R. P. ...	Method of treating latex*
	538	Termausen ...	Combined spout and hanger*
	541	Naugatuck Chemical Co.	Methods of preserving latex*
	551	Dunlop Rubber Co.	Improvements in direct production of rubber goods from dispersions of rubber*
	557	do.	Improvements in manufacture of rubber*
	558	Cresson ...	Improvements in composite rubber-faced surfacing material*
	566	Kendall & Graham ...	Rubber oil anti-malarial mixture*
	573	Dunlop Rubber Co. ...	Production of articles substantially of organic materials from aqueous dispersions of same*
	595	Cramer ...	Improvement in budding by excluding use of false material *
1929	601	Singhan ...	Addition to No. 536 (REVOKED)*
	627	Naugatuck Chemical Co.	Process for treating latex*
	628	do.	Treatment of rubber and products therefrom *
	629	do.	Treatment of latex*
	630	Perera & Cobb	Production of preserved rubber sheet
	634	Cramer ...	Method of grading planting material
	636	Walker ...	Combined spout and holder
1930	644	Schweizer ...	Apparatus for collecting and straining rubber latex
	648	Perera & Cobb	Improvements in production of preserved rubber sheet
	652	Naugatuck Chemical Co.	Preservation of latex *
	653	do.	Method of preserving latex*

Year	Number of Grant	Name of Grantee	Title of Invention
1930	659	Naugatuck Chemical Co.	Treatment of latex *
	664	do.	A method of concentrating rubber latex *
	663	do.	Preservation of latex *
	665	do.	Method of concentrating latex and removing non-rubber *
	671	Cargills	Preparation for prevention and treatment of disease
1931	677	Naugatuck Chemical Co.	Improvements in process for treating rubber latex *
	678	do	Improvements in treatment of latex *
	680	Willems	Machine for manufacture of sole crepe
	682	Meinesz	New apparatus for making rubber in form of sheet by atomising and drying latex *
	690	Buhrmann	Improvements in and process for baling
	695	Schweizer	Improvements in latex coagulating tanks *
	698	Parry Davis	Improvements relating to vulcanisation *
	699	do.	Improvements relating to roadmaking *
	702	W.H. Pratt	Improved machine for preparation of sheet
	703	Naugatuck Chemical Co.	Improvements in preservation of latex *
	704	Brunton	Improved instrument for tapping
1932	705	Singhan	Improvements in production of rubber pastes *
	712	Savege	Sheeting battery for rubber *
	718	Ungar & Schidrowitz	Process for manufacture of softened rubber *
	719	Kirby	Improvements in sectional units for coagulating tanks *

PART II

Registration of U.K. or other British Patents in F.M.S. 1914—1932

Year	No. of Certificate	U. K. Patent	Name of Grantee	Title of Invention
1923	4	219635	Utermark	Process for preparing concentrated milk sap *
1924	7	236633	Hammond	Process for the coagulation of rubber latex *
1924	13	226440	United States Rubber Plantations, Assignees of I. Traube	Improvements relating to the production of concentrated rubber latex and of rubber from rubber latex *
1925	47	252673	Anode Rubber Co. Ltd.	Method for the production of rubber goods directly from latex *
1927	58	294002	The General Rubber Co.	Method of treating rubber latex *
1927	65	288206	I.G. Farbenindustrie, A.G.	Improvements in the vulcanisation of latex *
1927	66	289022	do.	Improvements in the preservation of latex *
1928	67	300456	do.	Improvements in the preservation and treatment of latex *
1927	68	300719	do.	Improvements in the production of raw rubber from rubber latex *
1927	71	307315	Dunlop Rubber Co. Ltd.	An improved method and apparatus for concentrating or drying liquids *
1928	72	309245	I.G. Farbenindustrie Aktiengesellschaft	Improvements in the production of rubber from rubber latex *
1927	85	294412	do.	Improvements in the preservation and treatment of latex *
1928	95	319410	Dunlop Rubber Co. Ltd.	Improvements in or relating to the preparation of concentrated india rubber latex *
1928	102	324375	do.	Improvements in or relating to the production of reversible latex compositions *

Year	No. of Certificate	U. K. Patent	Name of Grantee	Title of Invention
1928	103	324104	Dunlop Rubber Co. Ltd.	Improvements in or relating to the manufacture of rubber articles *
1928	106	326497	do.	Improvements in or relating to the manufacture of goods of rubber or similar material *
1929	108	327451	do.	do.
1929	125	337269	Revertex Ltd.	Process of concentrating latices *
1927	127	293771	do.	Process for concentrating natural latices *
1929	130	332525	Dunlop Rubber Co. Ltd.	Improvements in or relating to the manufacture of goods of rubber or similar material *
1929	131	332526	do.	
1929	139	344875	Societa Italiana Pirelli and Ugo Pestatozza	Improved method and means of concentration of rubber latexes and other aqueous dispersions of rubber *
1931	140	363872	Revertex Ltd.	Process for the production of rubber-latex concentrates *
1932	147	382235	Metallgesellschaft A.G.	Process for inspissating or concentrating rubber latex *
	148	383062	Huttenbach, Lazarus and Sons Ltd.	Improvements relating to the manufacture of rubber sheet from coagulated latex *

PART III

S.S. Grants of Exclusive Privileges 1914—1932

Year	No. of Grant	Name of Grantee	Title of Invention
1914	257	Ilcken	Artificial drying of copra, rubber, cocoa, tobacco etc. by combination of rotary and tunnel hot air process
	260	U.S. Tyre Co., Ltd.	Improvements in vehicle tyres
	261	Reid	Process and apparatus for coagulating and curing rubber latex by breaking up and atomising and spraying by pressure evenly in thin layers on surface of a drum or other suitable surface revolving or stationary and in smoke or other fumes or gases
	262	Duncan	Improvements in the preparation and coagulation of rubber latex
1915	264	Hawthorn	Improvements in apparatus for coagulating, smoking and manufacturing rubber
	267	Jackson	A latex coagulating machine
	268	Dunlop Rubber Co.	Improvements in the manufacture of crude rubber
	269	MacLennan	Mechanical process for separating refuse such as bark, wood-scrap from naturally coagulated latex
	271	Ilcken & Down	Chemical process for manufacture of rubber from latex and for treatment of raw and scrap rubber
	272	do.	Apparatus for manufacture of rubber from latex
	273	Jackson	Device for throwing rain aside from tapping groove
	275	Nash	Tapping knife with renewable blades
	277	Gray	Holder for latex cup
	280	Trusty	Improved knife for tapping rubber
	283	Evans	Machine for washing, milling and cleaning lower grades
	284	Maude, Crosse, Pratt & Barrowcliff	Improvements in process for preparation of rubber by coagulating latex
1916	290	Beavis	Spout for collection of latex

Year	Number of Grant	Name of Grantee	Title of Invention
1916	293	Ilcken & Down	Improvements in chemical process for manufacture of rubber from latex
	296	Whiting & Bloomfield	Spout for collection of latex
	298	Hall & Paynter	Spout for collection of latex
	299	Barker	Improvements in process for smoking and drying rubber
	300	Teo Guan Tye	Improvements in extraction of Para rubber crepe from bark crepe
	301	Ilcken and Down	Improved chemical process for purifying inferior and scrap rubber
	302	Rasmussen	Process of conveniently handling and storing latex during coagulation and by which space required for storing large number of pans is reduced to a minimum
	303	Maclean	Process for preparation or refining and preserving raw jelutong rubber
1917	305	Sawh	Latex cup and hanger
	306	Thian Lock Choo and F.P. Loh	Process for manufacturing and refining jelutong from its latex
	309	Khoo Kim Lian	Improved knife for tapping rubber trees
	310	Jackson	Rubber shoe sole
	311	Arisaka	Packing and preserving latex
	313	Thomas and Maude	Improvements in coagulating rubber latex
	315	Ilcken and Down	Chemical process for manufacture of rubber from latex and treatment of raw and scrap rubber and gum
	317	Holt	Crepe rubber folder in form of drum with flange attachments
	321	Carty	Combined spout and hanger
	322	Jarvis	Preparation and pressure for packing rubber crepe or sheet by special apparatus
	325	Jarvis	Improvements in foregoing
	327	Arisaka	Treadle machine for washing and crepeing rubber
	329	Ilcken and Down	Process for obtaining maximum yield of rubber from latex
	334	Kwa Siew Tee	Combined process of coagulating and smoking with the "smoking-rubber" mixture
	335	Lambart	Improved spout and hanger

Year	No. of Grant	Name of Grantee	Title of Invention
1917	339	Maclean	All-weather water-proof cover for tapping cuts
	342	Gibson	Pressure gear for applying pressure to rubber or other material in boxes or bales
	344	Thian Lock Choo	Refining and preserving Jelutong
	345	Carey and Ash	Rain shield for tapping cuts
	349	Bailey	Device for baling
	354	General Rubber Co.	Improvements in rubber coagulum and process for preparation from latex
	355	do.	Improvements in rubber composition and process for production thereof
	356	do.	Treatment of rubber and similar materials
	357	do.	Improvements in rubber coagulum and process or preparation for vulcanisation
	358	do.	Improvements in process for baling rubber
	359	do.	Improvements in process and apparatus for treating coagulum
	360	do.	Improvements in process for treating latex and products therefrom
	361	do.	Improvements in adhesive rubber composition
	362	do.	Improvements in apparatus for treating latex
	363	do.	Improvements in process and apparatus for treating latex, including preparation for vulcanisation
	364	do.	Improvements in rubber coagula and preparation of same for vulcanisation
	365	do.	Improvements in process for separating rubber from rubber-containing material
	366	do.	Improvements in process for treating latex and products therefrom
1918	372	Watt	Improvements in machine for macerating and crepeing scrap
	373	Black & Simpson	Baling press
	375	Claessen	Utilisation of bark shavings from rubber trees
	376	Curran	Improved press for packing rubber

Year	No. of Grant	Name of Grantee	Title of Invention
1918	378	Sime	Latex cup
	387	Berendonck	Improvements in pneumatic tyres
	388	Stathouder	Improvements in process of preparing rubber by coagulation of latex
	389	Niblock	Machine for washing scrap rubber
1919	391	Roberts	Crepe-folding machine
	393	Hayley	Improved flexible wrapping for rubber
	397	Hunter Dry Kiln Co.	Process of treating rubber
	398	United Engineers Ltd.	Improvements to "Hillside" rubber press
	408	Stephen	Improvements in machines for cleaning scrap rubber
	413	Fish	Rubber Standardiser
	414	Davidson and Holland	Process for refining Jelutong
1920	419	Hally	Protective device for rubber trees
	426	Tan Teek Puan	Improved coagulant for rubber, to be called "Acetocol"
	427	Cammaert	Combined spout and cup-holder
	436	Whittaker and Ardron	Rainshield for rubber trees
	448	Han Tiong Sawh	Improved latex spout
	449	Hopkinson	Process for treating rubber-containing latex
	450	Hopkinson	Products obtained from rubber-containing latex
	453	Sayers	Improved pail for latex collection
	455	Gjorup	Self-baling folding case for rubber sheets
1921	460	Laub	Manufacture from latex of a coagulum which can be vulcanised immediately after drying and washing and including ingredients imparting specific properties to the rubber when vulcanised
	462	Laub	Manufacture of coagulum which can be vulcanised immediately after drying and washing

Year	No. of Grant	Name of Grantee	Title of Invention
1921	467	De Neve	Improvements in method and apparatus for tapping and collecting latex
	475	Cresson	Terra-caoutchouc blocks
	483	Miijachi	Producing sheets and slabs of rubber by use of porous and hygroscopic moulds
	491	Hansen	Implements to enable ploughs to be used in root-filled areas
	492	Stothard	Improvements in method and apparatus for collecting latex from trees
	493	Roa	Improved apparatus for treatment of latex
	495	Hodges	Self-contained mould vulcaniser
1922	496	Consigleire	Collapsible canvas bag for packing rubber
	497	Schidrowitz	Improvements in the manufacture of rubber
	503	Hopkinson	Production of a fabrication of rubber and filamentary material
	504	Barns	Reinforced rubber road and traffic surface
	507	Cheong Pheck Tee	Refining raw jelutong
	509	General Rubber Co.	Improved process for treating rubber and similar material
	511	McLeroth Tyre Co.	Improved air tubes for pneumatic tyres
	516	Bunker	Manufacture of chemical mixture for preservation of latex
	517	Firestone Tyre Co.	Improved method and apparatus for drying rubber
	530	Westendorp	Device for protecting tapping cut against rain
	533	Minton	Improvements in rubber or rubber-coated articles
	536	McLeroth Tyre Co.	Improvements in air tubes for pneumatic tyres
1923	544	Vultex Ltd.	Improvements in manufacture of rubber
	557	Smith	Rubber-cushioned ship's fender
	561	Blake and Offenberg.	Manufacture of resilient rubber brushes
	562	Koch	Improved implements for removing portions of the bark of trees
1923	566	Bosch	Improved instrument for tapping rubber trees

Year	No. of Grant	Name of Grantee	Title of Invention
1923	567	Jeffrey and Wilkinson	Process for conversion of latex of any specific gravity into a non-oxidisable rubber composition for flooring, mats, tiles and roofing
	571	Hoare, Dick and Adkins	Improvements in manufacture of sheet from latex and apparatus therefor
	572	General Rubber Co.	Improvements in process and apparatus for drying coagulable liquids
1924	577	Anode Rubber Co.	Process and device for immediate production of mechanically unworked pure rubber sheet from latex
	578	do.	For direct production of moulded articles from latex
	579	General Rubber Co.	Improvements in apparatus for drying rubber latex
	581	Parry Davis	Process for the manufacture of condensed rubber latex
	590	Shiro Satoh	Wire hanger for latex cup
	593	Stutchbury and Hauser	Improvements in manufacture of caoutchouc, balata and similar gums
	602	Tan Kah Kee	Improvements in manufacture of inner tubes direct from latex
	605	do.	Improvements in manufacture of rubber soles and heels
	611	Wilkinson	Improvements in the manufacture of rubber compositions from latex
	612	Shalless	Scrap washing machine
	620	Percival	Improved appliances for use in collecting latex
	625	Hopkinson	Process and apparatus for obtaining rubber from latex
1925	634	General Rubber Co.	Improvements in the manufacture of crude rubber
	642	do.	Improvements in the process and apparatus for drying latex
	647	Gill	Improvements in rubber rolling machine
	651	Boardman	Improved latex spout and hanger
	654	Dunlop Rubber Co.	Manufacture of an all-rubber tyre
	656	Raeber and Schweizer	Latex cup hanger
	660	K.D.P. Ltd.	Process and apparatus for concentrating latex
	670	Van der Mark	Improvements in articles of unvulcanised rubber

Year	No. of Grant	Name of Grantee	Title of Invention
1925	673	Laub	Manufacture of an ebonite or vulcanite veneer
1926	692	Anode Rubber Co.	Improvements in the direct production of rubber goods from emulsions
	702	Naugatuck Chemical Co.	Improvements in the manufacture of rubber-containing mixtures
	703	Anode Rubber Co.	Improvements in the manufacture of rubber goods from rubber emulsions
	708	do.	Method and apparatus for manufacture of rubber goods from rubber dispersions by electrophoretic means
	710	General Rubber Co.	Improvements in apparatus for drying latex
	730	Tan Kah Kee	Manufacture of rubber-soled wooden sandals
1927	732	Ritchie	Measurement of latex collected by individual coolies
	733	Rubber Electro Deposition Patents Ltd.	Improvements in the production of rubber
	737	Dunlop Rubber Co.	Production of rubber goods direct from latex
	738	Naugatuck Chemical Co.	Improved method of treating latex and products thereof
	740	Dunlop Rubber Co.	Method of producing articles substantially made of organic materials from dispersions containing the said organic materials.
	747	United States Rubber Plantations	Method of treating latex and products therefrom
1928	748	Naugatuck Chemical Co.	Method of preserving rubber latex
	750	Cresson	Improved composite rubber-faced surfacing material
	752	Cargills	Preparation for treatment and prevention of disease in rubber trees
	758	Dunlop Rubber Co.	Improvements in the manufacture of rubber articles
	774	do.	do.
	788	I.G. Farben-Industrie A.G.	Improvements in the process for preserving and treating latex
	802	Dunlop Rubber Co.	Improvements in the manufacture of rubber
	805	do.	Improvements in the direct production of rubber goods from dispersions

Year	No. of Grant	Name of Grantee	Title of Invention
1929	807	McGhee	Improvements in the manufacture of rubber-soled footwear
	808	Hultman	Process of making rubber-like materials
	828	Naugatuck Chemical Co.	Treatment of latex
	835	do.	Treatment of rubber and products obtained therefrom
	841	Gillespie & Grant	Improved apparatus for hanging rubber sheet in smoke houses
	851	Perera and Cobb	Chemical production of preserved rubber sheets
	853	K. D. P. Ltd.	Process for concentrating natural latices
1930	854	Nakamura	Rubber tapping knife
	855	Wilhelmi	Method and device for manufacturing rubber footwear
	858	Naugatuck Chemical Co.	Method of preserving latex and products thereof
	859	Schweizer	The S-D. patent strainer for latex
	869	Naugatuck Chemical Co.	Preservation of latex
1931	872	do.	Improvements in the treatment of latex
	873	McGhee	Improved pressure moulds for manufacture of rubber footwear
	889	Naugatuck Chemical Co.	Improvements in the preservation of latex
	891	K. D. P. Ltd.	Process of concentrating latices
1931	892	Schweizer	An all metal latex coagulating tank
	893	Parry Davis	Improvements relating to vulcanisation
	897	do.	Improvements relating to roadmaking
	901	Willems	Method for the manufacture of sole crepe
	905	Cresson	Improved manufacture of Terra-caoutchouc blocks or slabs for road facing, flooring etc.
	907	Pratt	Improved machine for the preparation of sheet rubber

Year	No. of Grant	Name of Grantee	Title of Invention
1932	910	Malcolm Watson	Improvements in the collection of latex from trees
	914	Sime Darby	Improved latex coagulating tank
	915	Ungar and Schidrowitz	Improvements in the manufacture of rubber
	Specn. No 6406/32	E.H. Kirby	Improvements in latex coagulating tanks—sectional units

PART IV

Registration of U.K. and other British patents in S.S. 1914—1925

Year	S.S. Specification No.	British Patent No.	Name of Holder	Title of Invention
1914	568	11470	Davidson	Improvements in the extraction of rubber from latex
	575	26270	Wickham	Improvements in apparatus for treating latex
	580	25256	Davidson	Improvements in the extraction of rubber from latex
	590	20118	Nederland G. P. Mat.	Process for the manufacture of gutta-percha
1915	593	13438	Davidson	Improvements in the treatment of rubber latex
	616	16840	Pinto	Improved method of coagulating latex
1916	629	28118	Bosch	Improved instrument for tapping
	647	22490	Davidson	Improvements in machinery for rubber
	648	22489	do.	Improved apparatus for coagulating latex
	649	17168	do.	Improvements in the manufacture of rubber
1918	758	Ceylon No. 1462	Wilkins	Device for protecting tapping cut from rain
	766	102495	Bosch	Improvements in instrument for tapping rubber trees
	817	103298	Lintner	Process and apparatus for coagulating latex
	818	119488	Kapoewas Rubber Co.	Cup hanger
1920	896	124680	W.E. Lake	Improved process for treating and handling latex
1921	918	151344	Davidson	Improved treatment of fresh coagulum
	937	159106	do.	do.
1922	1000	129826	Peachey	Process for vulcanisation of caoutchouc
1924	1181	Ceylon No. 1833	Bamber	Manufacture of crude dipentene from rubber

PART V

Registration of U.K. and other British patents in S.S. 1925—1932

Year	Registration number	British Patent number	Name of Holder	Title of Invention
1925	20	236633	Hammond	Process for coagulation of latex
	21	219635	Utermark	Process for concentrating milksap
1926	31	226440	U. S. R. P.	Improved process for the concentration of latex
	38	245405	Beech Nut Co.	An improved jelutong product
1927	61	294002	General Rubber Co.	Improvements in method of preserving latex
1928	77	252673	Anode Rubber Co.	Production of rubber goods direct from latex
1929	94	288206	I.G. Farbenindustrie	Improvements in the vulcanisation of latex
	95	289022	do.	Improvements in the preservation of latex
	96	307315	Dunlop Rubber Co.	Improvements in apparatus for concentrating and drying liquids
	97	303544	do.	Improvements in the manufacture of goods from an aqueous dispersion of, or containing, rubber
	99	300456	I.G. Farbenindustrie	Improvements in the preservation and treatment of latex
	102	300719	do.	Improvements in the production of raw rubber from latex
	103	309391	Dunlop Rubber Co.	Improvements in the production of articles substantially made of fabric, coated, proofed or impregnated with organic materials and the production of sheetings of organic materials
	114	312257	do.	Process for the production of rubber tubing
	115	311844	do.	Process and device for direct production of thread from concentrated and compounded latex
1930	117	309245	I.G. Farbenindustrie	Improvements in the production of rubber from latex
	119	308626	Dunlop Rubber Co.	Improvements in the manufacture of articles from aqueous dispersions containing organic materials

Year	Registration number	British Patent number	Name of Holder	Title of Invention
1930	129	319410	Dunlop Rubber Co.	Improvements in the process of concentrating latex
	134	324104	do.	Improvements in the manufacture of rubber articles
	136	327451	do.	Improvements in the manufacture of rubber goods
	138	324375	do.	Improved process for the production of reversible rubber latex compositions
1931	143	330970	do.	Process for manufacture of articles from aqueous dispersions
	150	337269	Revertex Ltd.	Process for concentrating latex
1932	161	332525	Dunlop Rubber Co.	Improvements in the manufacture of rubber goods
	162	332526	do.	Improvements in the manufacture of rubber goods
	168	344875	Soc. It. Pirelli	Improved method for the concentration of rubber latex

A NOTE ON ACETIC ETHER AND CARBON TETRACHLORIDE WITH RUBBER AS A KILLING AGENT FOR INSECTS

BY

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To the field entomologist the cyanide of potassium bottle is perhaps the best known and most widely used killing agent for insects. For the majority of species it is very satisfactory, but the poison acts on the respiratory and nervous systems and causes some contraction which, unless counteracted as soon as the *rigor mortis* has passed, is a disadvantage especially where the higher Hymenoptera are concerned. Furthermore, during *rigor mortis*, which takes place soon after the death of an insect and lasts from 12 to 24 hours, the appendages of certain species become brittle and are liable to fracture.

A suitable killing agent for Hymenoptera is acetic ether (ethyl acetate), but the method of using a bottle fitted with a plug of cotton wool soaked in this very volatile chemical is inconvenient, as it requires frequent replenishment especially in the tropics and necessitates carrying about a reserve supply of the fluid. This refers also to other killing agents such as chloroform and benzine.

During May 1932 I received from Mr. H. T. Pagden (late of the Department of Agriculture, F.M.S. and S.S.) a letter explaining a method that had been evolved by Mr. G. Salt whereby killing tubes of chloroform, benzine and ether could be made by a very simple process.

Rubber absorbs these substances, and the method Mr. Salt employs is to chop up some rubber into fine pieces, place them in a tube, and add sufficient of the required fluid to cause the rubber to swell up and form a more or less homogeneous jelly-like mass sufficiently stiff not to flow up the tube.

On receipt of this letter I discussed the matter, and its possibilities with other combinations, with Dr. A. S. Corbet and Dr. Rhodes of the Rubber Research Institute, Malaya, and they obligingly carried out some experiments with crepe rubber in

carbon tetrachloride, and in acetic ether (75 per cent.) and carbon tetrachloride (25 per cent.).

With this information the writer of this note attempted some further experiments by reducing the amount of carbon tetrachloride to 15 per cent. and increasing the acetic ether to 85 per cent. This gave the desired consistency and the lethal action of the preparation (though very gradually diminishing in potency) has remained satisfactory without futher replenishment after being in use for a period of eight and a half months. By this time the colour of the prepared rubber has turned to a dark chestnut-brown and the bulk has shewed a slight decrease.

The tubes referred to are ordinary glass specimen tubes, six inches long with a diameter of one inch, and fitted with a cork one inch thick. Rubber bungs are of course unsuitable in this case as they swell up and perish within about forty eight hours.

The method of preparation is extremely simple; part of a sheet of crepe rubber is torn up into small fragments and placed at the bottom of the tube to a depth of about one inch; then a sufficient quantity of the mixture (carbon tetrachloride, 15 per cent; acetic ether, 85 per cent.) is poured into the tube to cover the rubber. The tube is then corked and placed in an upright position. After twenty-four hours the rubber, which will have swollen considerably, should be pressed down and all air bubbles excluded. In a further forty eight hours the rubber becomes slightly plastic, and should be pressed down again. Excess fluid may now be poured off, and about five thicknesses of blotting paper, cut to size, placed on the top of the prepared rubber to absorb superfluous moisture. On this is imposed a plug of dry cotton wool, with another five thicknesses of blotting paper above it to form a flat surface.

Several tubes may be prepared at the same time, and one should be reserved for Hymenoptera, one for Diptera, one for Coleoptera and so on, as it is never judicious to put massive insects in the same receptacle as fragile specimens.

Tubes thus prepared have been found very satisfactory for killing the above mentioned insects and especially those species that are liable to retract their appendages as death supervenes. In the present instance they remain in a flaccid state for a considerable time after being killed and generally with their trophi and genitalia exserted. If it happens that these organs are not actually displayed, they can be exposed easily with the point of a pin when the specimen is removed from the tube. This is a considerable advantage for it saves the subsequent relaxing and dissection so often necessary when cyanide has been used as a killing agent.

As an offset it may be mentioned that the green colour present in many Orthoptera (Tettigoniidae, Aridiidae), and some Neuropt-

era (Chrysopidae) is liable to turn yellow if these insects are left in the influence of the vapour for too long; and during hot weather a slight condensation may appear on the inner walls of the tube. This will do no damage, however, to Coleoptera or Hymenoptera for any dampness incurred by a specimen disappears almost immediately on exposure to the air, but it is inadvisable ever to use damp tubes for Lepidoptera as scales become detached from the wings through adhering to the moisture.

In view of the fact that the writer has little opportunity, at the moment, of enlarging upon the above principles, he has recorded these observations as they appear to contain distinct possibilities for further development.

Note.—In this connection experiments are being carried out by the Rubber Research Institute with a view to determining the possibilities of using rubber impregnated with insecticidal fluids in control of white ants. Most fumigant insecticides are very evanescent in action and necessitate frequent applications, whereas, if applied absorbed in rubber, the action is less intense but more prolonged which is highly desirable in the case of control of the white ant pest. Carbon bisulphide, ortho- and para-dichlorbenzene and trichlorethylene are fumigants which might be used in this way. (B.J.E.)

EFFECT OF FERTILISERS AND COVERS ON GROWTH OF YOUNG RUBBER. IV

BY

W. B. HAINES

The following report summarises the more recent results on areas under the control of the Soils Division at the R.R.I. Experiment Station. The original planting was 4½ years old at the time of the latest measurements. Interesting results with rubber newly planted on plots which have long been under various covers are also included.

BLOCK 6. MANURIAL EXPERIMENT.

This manuring experiment shows no change from the position indicated in previous reports (This Journal Vol. 4, No. 2, p. 126; Vol. 3, No. 2 etc.). The following table gives the average girth (at 1 foot) of the various plots, together with the increments in the last three six-monthly periods. Each figure is the mean of six plots (and each such plot value is a mean of some 80 trees).

TABLE I

Block 6. Girth in inches at 1 foot.

	A Control	B Cattle manure	C Complete inorganic	D N only	E N & P	F P & K
6-monthly increments 3 - 3½ years	2.83	2.96	2.94	2.89	2.98	2.65
6-monthly increments 3½ - 4 „	3.22	3.61	3.20	3.14	3.28	3.19
6-monthly increments 4 - 4½ „	2.92	2.63	3.06	2.85	2.82	2.88
Present girth at 1 ft.	22.96	24.36	23.85	23.09	23.14	23.06

The singular uniformity shown in these figures is reflected in the calculation of the standard error of the experiment as only 1.20 per cent.

BLOCKS 7 AND 8. COVER CROPS.

A similar table is given for the more recent history of Blocks 7 and 8. The layout does not contain any replication of plots so

that a proper estimate of significance has not been attempted, but the lie of land is very even and some guidance may be obtained from Block 6 which is contiguous and of the same planting.

TABLE II

Girth and 6-monthly increments in inches at 1 foot

		Control	Lamtoro		Control	Crotalaria		Control	Calapogonium
			Pulled	Unpulled		Pulled	Unpulled		
Block 7	years								
6-monthly increments	3 - 3½	3.08		3.10	3.05		2.59	3.11	2.70
	3½ - 4	3.17		3.76	2.91		3.30	2.99	2.97
	4 - 4½	2.61	2.82	1.90	2.80	3.21	2.23	3.00	1.98
Present girth		24.32	23.40	22.71	23.16	21.75	20.55	23.78	20.81
Block 8	years								
6-monthly increments	3 - 3½	3.57		3.59	3.36		2.86	3.22	2.86
	3½ - 4	2.80		3.37	3.75		3.50	2.96	3.49
	4 - 4½	2.27	4.54	2.72	1.56	2.99	2.80	2.45	2.45
Present girth		23.62*	25.09*	24.25*	32.62*	23.10	21.53	23.18	21.19

As previously noted the *Lamtoro* plots have reached a level with the controls, while the *Crotalaria* and *Calapogonium* plots remain a little behind. Block 7 with timber left lying is a little behind Block 8 which was clean cleared. None of the differences are large. The only outstanding feature of the recent measurements is the large increase in the growth of that area in Block 8 which had *Lamtoro* growing at first, but from which it was pulled rather less than 2 years ago. This response stands alone, however, and will require verification from future figures.

Block 11. Belukar (Secondary jungle) plots

Since the last report it has been decided to further sub-divide Block 11 by clearing a strip in the middle, consisting of 6 rows in the slashed half and 6 rows in the unslashed half. The fact of retarded growth seemed so clearly established now that it was important to see how far and how quickly the young trees would recover when the competition of the undergrowth was removed, and the trees given full opportunity to make use of the indubitably good soil conditions which had been maintained.

Table III shows the recent increments in growth and the present mean girths at 1 foot.

*The trees from which these averages are calculated are alternated with buddings

TABLE III

Block 11. *Girth measurements in inches at 1 foot*

Planting Distance			Unslashed	Cleared	Slashed
22ft. × 22ft.	Increment	3 - 3½ years ...	0.97		1.15
		3½ - 4 „ ...	2.55		2.82
		4 - 4½ „ ...	1.29	1.97	2.25
		Present girth ...	17.20	17.35	18.53
22ft. × 11ft.	Increment	3 - 3½ years ...	0.51		1.16
		3½ - 4 „ ...	2.20		2.77
		4 - 4½ „ ...	1.07	1.59	2.10
		Present girth ...	14.76	17.10	17.69

The values for other clean weeded plots of the same date of planting, as shown above, are between 21 and 24 inches, so that Block 11 is now very definitely behind. The slashed half has been selectively weeded for over a year and contains only a mixed flora of plants regarded as useful.

The feature of Table III that is specially interesting is the very low increment between the ages 3—3½ years. This is the period which contained the first true wintering, and it is apparent that the temporary weakening of the trees gave the competing undergrowth an advantage of which full value was taken. This explanation receives additional support in the fact that, where the undergrowth was uncontrolled, the effect was most severe (one third of the development which was normal for the period on clean weeded plots.)

It should be remarked that, during the few months since clearing the middle strip, the trees there have improved most remarkably in their foliage, and it is to be anticipated that this will be reflected in additional growth over the next period of measurement.

Block 17d. Cover Crops.

Part of this block was originally planted in strips of covers without rubber and, after four years, stumps from pod-picked seed of various proved clones were planted in these covers. Only such disturbance was made in the cover as was necessary for the planting. Alternate plants were assisted over half the area by placing well

rotted Adco artificial farmyard manure (made on the Station mainly from grass cuttings) in the holes. The stumps came away very uniformly and now, after eight months, show the following very interesting differences in growth (Table IV). The *Vigna* has always grown so very sparsely that this plot may, to all intents and purposes, be regarded as a clean control.

TABLE IV

Stumps planted in well established covers

Covers (in order of performance)	Mean height in feet of stumped seedlings			
	Treated half of plots			
	Mean of all	Mean of manured	Mean of unmanured	Benefit of Adco (per cent)
Crotalaria ...	7.44	8.08	7.63	5.9
Lantoro ...	6.87	7.54	6.67	13.0
Tephrosia ...	6.80	7.48	6.68	12.0
Calapogonium	6.74	7.32	6.57	11.7
Mikania ...	6.51	7.03	6.68	5.1
Vigna (very poor growth) ...	6.35	6.88	5.85	17.5
Pueraria ...	6.33	7.03	6.42	9.2
Centrosema plum. ...	6.20	6.81	6.03	13.0
Mimosa ...	6.13	6.59	6.38	3.2
Centrosema pub. ...	4.82	5.07	4.90	3.7

The effects to be noted in these figures can be partly attributed to the cumulative effect upon the soil of the covers standing for four years. But, in the writer's opinion, they may be mainly attributed to the present competitive and other effects due to the cover being already in possession. Thus the maximum effect of manuring is on the practically clean *Vigna* strip, where there is no competing root system to take the extra food from the rubber. On the other hand the smallest effect from manuring is in the *Mimosa* and *Centrosema pubescens* plots, where the cover is most vigorous and has not only taken most of the advantage of the Adco fertiliser, but has also kept the rubber back to the greatest extent.

The shrub covers are by far the best, which may be partly due to their better and deeper root action on the soil, but also partly to the better shade protection afforded the young rubber plants. *Centrosema* comes out of the test very badly, and stresses the comment often made by the writer when inspecting young clearings, namely, that when one sees an exceptionally fine and vigorous creeping cover one should balance one's admiration by a critical examination of the rubber trees lest one unwittingly overlooks the retarding effects of competition which may be present.

The next table (V) gives the relative growth of the young rubber which was originally planted further along these same strips of cover at the same time as the covers, and so has grown in conjunction with them from the commencement. In consonance with the results elsewhere we find that clean weeding (i.e. the plot where the *Vigna* was a failure) has given the best growth. *Lamtoro* is very little behind with *Crotalaria* next, while the worst growth of all is on the *Centrosema pubescens* plot. The values for the seedlings are the most reliable since the figures for the buddings still show the disturbing effects of the trees where successful budding was late.

TABLE V

Mean girth in inches at 1 foot from ground

		Buddings	*Seedlings*
Lamtoro	...	6.57	12.63
Tephrosia	...	5.67	10.51
Crotalaria	...	5.80	11.40
Mimosa	...	5.23	10.60
Mikania	...	4.85	10.25
Pueraria	...	4.65	10.22
Calapogonium	...	4.67	10.41
Centrosema plum.	...	5.43	10.95
Centrosema pubes.	...	5.17	9.79
Vigna (almost clean)	...	6.71	13.03

Further evidence of the retarding effect of *Centrosema pubescens* is provided in Block 17A. Here the trees have received a regular treatment with a complete chemical manure. On the clean weeded plots the girth at three years of age is 15.15 inches, which is exactly the same as the cattle manure plots in Block 6 at the same age. On the *Centrosema* plots the retardation of tree growth is 24.3 per cent. for interplants established six months after the cover, and 12.5 per cent. for plants established at the same time as the cover.

BLOCK 19. CULTIVATION EXPERIMENT

Table VI gives the position of the cultivation plots now, after 14 months, as compared with the position of the same plots at the time of the previous report (7 months). The experiment has 9 plots—three treatments in triplicate, on ground which was previously in grass. In each series of measurements the figures (mean of three plots) are given in terms of the grand mean as 100.

TABLE VI

Cultivation Experiment (original planting 3½ years old).

Treatment	Girths compared with grand mean as 100		
	Previous report 7 months from first cultivation		Now 14 months after first cultivation
	First Buddings	Interplants	
1. Grass left	97.0	96.2	93.2
2. Dug & weeded	102.8	97.8	104.8
3. Dug periodically with regeneration of grass in between	100.4	106.1	99.5

The standard error of the second series of measurements was 1.93 per cent. So far the clean weeded plots are doing best, while the grass plots show a tendency to fall behind. Of these two results the effect of grass may be judged significant, while the effect of weeding is only barely significant.

BLOCK 23. CATCH CROPS

On this block are a large number of plots (17 were used in the results reported) where the rubber is interplanted with tapioca, pine-apples and coffee. The layout does not permit of very critical comparisons, but the following summary of the last measurements is sufficiently interesting to be put on record. The effect of tapioca is very damaging to the rubber not only in growth but in the incidence of root disease. The rubber grown in conjunction with coffee gives the best result so far, no doubt because the conditions there have been nearer to clean weeding exposure than in any other case.

TABLE VII

Growth of 2½ year old rubber with interplanted crops, compared with grand mean (=8.13 inches girth at 1 foot) as 100

Legume cover *(Centrosema* and *Pueraria)*	...	101.1
Coffee	...	116.2
Tapioca	...	76.4
Pineapples	...	106.5

SUMMARY

A concise statement is given of the more recent results at the R.R.I. Experiment Station on the effects of fertilisers, covers, cultivation methods and catchcrops on the growth of young rubber.

In all cases the early effect is for the cover to reduce growth of the rubber by its competition for food, and this effect has been the most prolonged in the case of the plots with a natural cover.

Centrosema pubescens does not justify its popularity in these comparisons, while shrubby covers like Lamtoro are showing the more favourable results.